Instruction Manual

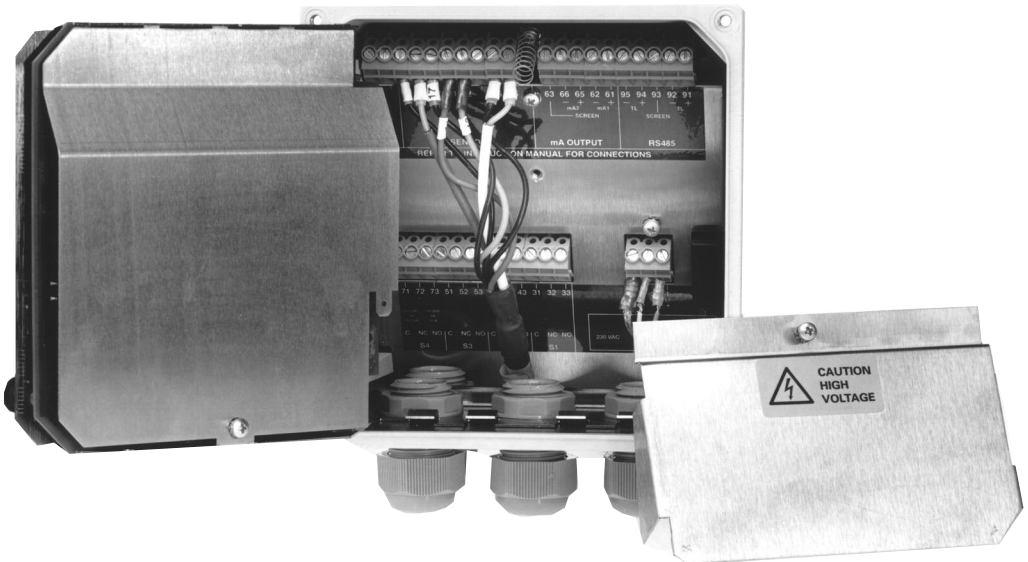
Model ISC402G Inductive Conductivity Converter

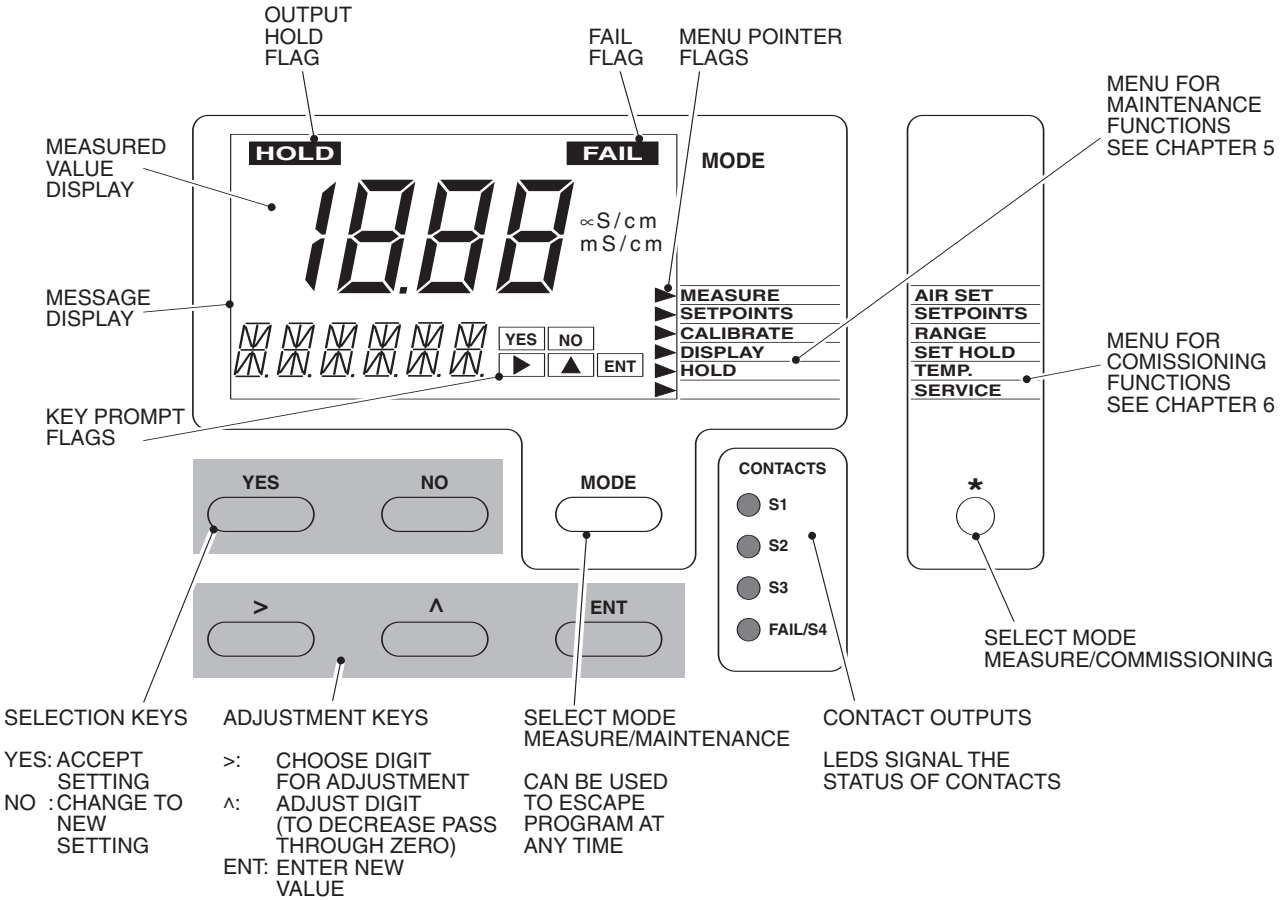
EXA

CE

YOKOGAWA

IM 12D8C2-E-E
6th Edition


63 66 65 62 61 95 94 93 92 91
mA OUTPUT
RS485
CAUTION
HIGH
VOLTAGE



NOTE: First digit changes from 0, 1, -1, - to blank

Code	Function	Use	Default	Section
01	Temperature sensors and units	Select sensor type and units	0.0	7-1
02	Installation factor	During start-up	1.88 cm^{-1}	7-2
03	Weight indication	Read concentration directly	0.0	7-3
04	Output range	Select output range	1.1	7-4
05	Output function	Conductivity (linear or table) and/or temperature	0.0	7-5
06	mA table 1	Current output	-	7-6
07	mA table 2	Current output	-	7-6
08	Contact S1	Program function	2.0	7-7
09	Contact S2	Program function	1.0	7-7
10	Contact S3	Program function	0.0	7-7
11	Contact S4	Program function	3	7-7
12	Proportional range	Set range	10% [%]	7-8
13	Proportional period	Set period	10 [sec]	7-8
14	Proportional frequency	Set frequency	70 [pulses/min]	7-8
15	Delay time and Hysteresis	Delay time and Hysteresis	0.2 [sec] 2.0 [%]	7-9
16	Auto return	Time-out function	1	7-10
17	Burn function	Signal fail on output	0	7-11
18	Temperature adjustment	Adjust temperature offset		7-12
19	Temperature coefficient	Adjust TC	2.1 [%]	7-13
20	Reference temperature	Only if different from 25 °C	25/77 [°C/ °F]	7-14
21	Alarm time-out	Timer function	0	7-15
22	Set time	Set current time	-	7-16
23	Temperature hysteresis	Set hysteresis temp. alarm	1.0/2.0 [°C/ °F]	7-17
24	Enable *Setpoint adjust in maintenance	Allow access to SETPOINT function	0	7-18
25	Deactivate Error E6	Disable low conductivity error	1	7-19
26	Soft fail	Program errors to signal fail	1 [all codes]	7-20
27	Communication setup	Set-up communication link to P.C.	0.1	7-21
28	LOG.CLR	Clear logbook	0	7-22
30	Select matrix	Select matrix temperature compensation	-	7-23
31-36	Program matrix	User program matrix	-	7-24
50	Test	Built in test	-	7-25
55	Defaults	Restore default values	-	7-26
66	Passcodes	Protect data	0.0.0	7-27

Chapter Description Page

INSTRUMENT DESCRIPTION AND CONTROLS Front cover

SERVICE SETTINGS Front matter

CONTENTS Front matter

1. INTRODUCTION
1-1. Application....1
1-2. Measurement principle....1
1-3. Functional description....2
1-4. Instrument check....2

2. SPECIFICATIONS
2-1. General specifications....3
2-2. Functional specifications....4
2-3. Environment and operational conditions....5
2-4. Construction....5
2-5. Regulatory compliance....6
2-6. Model and suffix codes....6

3. INSTALLATION AND WIRING
3-1. Installation and dimensions....7
3-1-1. Installation site....7
3-1-2. Mounting methods....7
3-1-3. Installation of the sensor....9
3-2. System configuration....10
3-3. Wiring....11
3-3-1. Preparation....11
3-3-2. Wiring of power supply....13
3-3-2-1. General precautions....13
3-3-2-2. Access to terminal and cable entry....13
3-3-2-2a. Grounding the housing....13
3-3-3. Switching on the instrument....13
3-3-4. Wiring the contact signals....14
3-3-4-1. General precautions....14
3-3-4-2. Contact outputs....14
3-3-5. Wiring the analog output signals....14
3-3-5-1. General precautions....14
3-3-5-2. Analog output signals....14
3-4. Wiring the sensor....14
3-4-1. General precautions....14
3-4-2. Connecting the sensor cable to the transmitter....14

Chapter Description Page

4. START UP
4-1. The DISPLAY functions....15
4-1-1. The primary display....15
4-1-2. The secondary display....15
4-1-3. Annunciators....15
4-2. The output RANGE functions....15
4-2-1. Output linear to conductivity....15
4-2-2. Output linear to concentration....15
4-2-3. Output linear to temperature....15
4-2-4. Contact Input....15
4-3. Temperature compensation....16
4-3-1. Field calibration of (linear) temperature compensation....16
4-3-2. Programming of calculated temperature coefficient....16
4-3-3. Selection of preprogrammed electrolyte solutions....16
4-3-4. Programming of complex non-linear, conductivity dependent temperature coefficient using an easy 5 x 5 matrix structure....16
4-4. Calibration....16
4-4-1. Air calibration/Air set....16
4-4-2. Programming of the installation factor....16
4-4-3. Calibration using a sample....16
4-5. Contact output function....16
4-6. Operations overview....17
4-7. Cleaning....18
4-8. Battery....18

5. CONFIGURATION IN MAINTENANCE MODE
5-1. Calibration....19
5-2. Selecting a value to display....22
5-3. Use of the hold function....24
5-4. Adjusting the set points....26

6. CONFIGURATION IN COMMISSIONING MODE
6-1. Adjusting the set points....28
6-2. Output range adjustment....30
6-3. Set-up Hold function....32
6-4. Temperature compensation....34
6-5. Air set....38

Chapter Description Page

7. CONFIGURATION IN SERVICE MODE

Introduction 41
7-0. Access to service settings 42
7-1. Temperature sensor & units 43
7-2. Installation factor adjustment 43
7-3. Weight % on second display line 44
7-4. Output range 44
7-5. Output function 45
7-6. Output table for non-linear range 45
7-7. Contacts S1 to S4 47
7-8. Settings for proportional control 48
7-9. Setting the process alarm function 49
7-10. Auto return function 49
7-11. Signalling of fail condition 50
7-12 Temperature adjustment 50
7-13. Temperature coefficient 51
7-14. Reference temperature 52
7-15. Timer on contact function 52
7-16. Setting the clock 52
7-17. Setting temperature hysteresis 53
7-18. Enable setpoint adjustment in maintenance 53
7-19 Disable Error E6 53
7-20. Fail status signalling 54
7-21. Communications clear 54
7-22. Logbook clear 55
7-23. Selection of standard electrolytes 55
7-24. Matrix Temperature Compensation 56
7-25. Built-in Test function 58
7-26. Restore default settings 58
7-27. Data protection by three digit codes 59

Chapter Description Page

8. TROUBLE SHOOTING

8-1. Introduction 60
8-2. Self diagnostics of the electronics 60
8-3. Checking during operation 60
8-4. Error messages and explanation 61

SPARE PARTS 63

EXPLODED VIEW 64

ERROR MESSAGES 65

CODED SERVICE SETTINGS (DEFAULTS) ....Rear cover

1. INTRODUCTION

1-1. Application

The model ISC402G inductive conductivity mains powered converter is designed for use with the Model ISC40 sensor. This revolutionary conductivity measuring system features ± 0.5% accuracy over a wide range of conductivity values (1 to 2,000,000 µS/cm) and process temperatures (-30 to 150 °C/-22 to 302 °F) without changing cell constant or recalibration.

The ISC402 transmitter is designed for application in which the concentration of acid, alkali or salt solutions is measured for process control purposes. The power supply can be from most AC or DC sources. The four separate supply options make it a universal unit. As all operating parameters are stored in non-volatile memory there is no danger when power drops occur. The instrument has a 'watchdog' timer which will always return it to the normal operating status after power has been removed. The unit can linearise the output range in concentration units and offers the potential for sufficient "matrix" temperature coefficient depending on the process composition.

A self-tuning preamplifier provides a very accurate measurement over the full measuring range. The ISC402 also features auto zeroing to eliminate traditional temperature and long term drift caused by magnetic offset between the two toriods.
The Model ISC40 sensor is rugged steel-backed sensor encapsulated with the highest quality engineering plastic known today (Vitrex PEEK) for long service life in both abrasive and chemically corrosive processes.

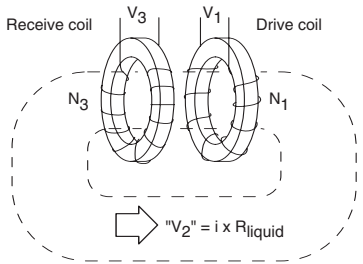
The stainless steel mounting thread and the Viton gasket allow safe and reliable installation. The long insertion depth allows for installation of the sensor either by a bulkhead mounting through a flange or tank wall, or by using one of the process adapter kits (e.g. for flow-through or immersion service).

The large bore, greater than 17 mm (11/16 in), gives long-term stability, preventing measuring errors caused by coating or plugging. The large bore also offers fast response even at low flow rates.

1-2. Measurement principle

Contrary to contact electrode conductivity, the EXA ISC Series analyses the conductivity without any contact between electrodes and process fluid. The measurement is based on inductive coupling of 2 ring transformers (Toroids) by the liquid.

Inductive conductivity measurement principle



The transmitter supplies a reference voltage at a high frequency to the "drive coil". The core of this coil is of a high permeability magnetic material, and a strong magnetic field is generated in the toroid.
The liquid passes through the hole in the toroid and can be considered as a "one turn" secondary winding.

The magnetic field will induce a voltage in this secondary winding. The induced current in the liquid winding is proportional to this voltage and the conductance of the liquid "one turn winding" is according to Ohm's law.
The conductance (1/R) is proportional to the

specific conductivity and a constant factor that is determined by the geometry of the sensor (length divided by surface area of the hole in the toroid) and the installation of the sensor.

There are 2 toroids mounted in the "doughnut" shaped sensor. The liquid also flows through the second toroid and therefore the liquid turn can be considered as a primary winding of the second ring transformer.
The current in the liquid will create a magnetic field in the second toroid. The induced voltage being the result of this magnetic field can be measured as an output.
The output voltage of this "receive coil" is therefore proportional to the specific conductivity of the process liquid.

1-3. Functional description

The EXA ISC402G is a real time micro-controller operated conductivity-analyzing system. It uses a dedicated micro-controller to control all functions necessary in such a system.

The input and output functions are concentrated in the analog section of the instrument. Even these functions are operated through special interfaces designed to minimize interference with the digital functions. All functions are executed separately.

The user-interface is limited to a basic set of 6 keys accessible through the flexible window cover.

The software is designed with the user in mind. It uses a simple 3 layer set-up to communicate with the operator by giving messages on the second line of the display area and also indicates which keys should be pressed.
The keys are scanned continuously and the actions are taken immediately. An extensive system of checking values and parameters is implemented.

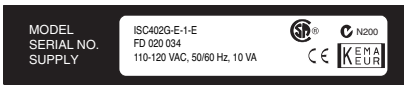
From the outside the ISC402G looks and works just as a normal conductivity transmitter. The operator has only access to those functions that are needed for regular maintenance of the analyzer. Traditional transmitters feature simplicity and ISC402G offers the same simplicity and the processing power of the microprocessor makes it possible to have a much higher level of functionality and flexibility.

The power of the microprocessor is used for:
- Diagnostic functions to increase the dependability of the instrument.
- A self-tuning preamplifier to increase the rangeability to cover almost all conductivity applications.
- Input/output flexibility to offer the user solutions to compatibility problems and to non-linearity characteristics of some electrolytes.
- Auto zeroing to insure long term stability
- Sophisticated temperature compensation to achieve temperature independent readings for even the most difficult processes like Sulphuric Acid and Sodium Hydroxide.

1-4. Instrument Check

Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant Yokogawa sales office.
Make sure the model number on the textplate affixed to the top of the display board of the instrument agrees with your order.

NOTE:
The textplate will also contain the serial number and power supply selection. Be sure to apply correct power to the unit.



Check that all parts are present, including mounting hardware, as specified in the option codes at the end of the model number. For a description of the model codes, refer to chapter 2 of this manual under General Specifications.

Basic parts list:
- Converter EXA ISC402G
- Packet with special cable grommet and blanking pieces
- Packet with 4 screws for mounting on a panel (M6x8mm)
- Optional mounting hardware when specified.

2. SPECIFICATIONS

2-1. General specifications

A. Input specifications : Yokogawa Model ISC40 inductive conductivity sensor with integrated temperature sensor YSI thermistor PT 1000 Ω.

B. Measuring range
- Conductivity : 0 to 1999 mS/cm [at 25 °C (77 °F) reference temperature].
- Minimum conductivity at process temperature : 0.5 µS/cm.
- Maximum conductivity at process temperature : 3000 mS/cm.
- Temperature : -30 to 150 °C (-22 to 302 °F).

C. Indicating range
- Main display : 0.0 µS/cm to 1999 mS/cm.
- Message display : -30 to 150 °C (-22 to 302 °F); 0 to 100.0 %.

D. Transmission signal : Two outputs, each 0/4-20 mA DC, maximum load 600 Ohm, isolated from input and communication signals. A common negative line is used for both outputs.
Output current on fault condition is 22 ± 0.5 mA (user selectable). Both signals can be held (fixed or last value) during maintenance
mA 1 and mA 2 can be configured for independent conductivity ranges. mA 2 can alternatively be used to give a temperature signal.
- Status Alarm : High or Low process.
- Serial communication : Bi-directional according to EIA-485 standard. Isolated from input and analog signals.

E. Transmission range
- Conductivity : User programmable to any conductivity range within the indicating range. Configurable for linear and non-linear signals.
- Minimum span : 10 µS/cm.
- Maximum span : 1999 mS/cm.
- Maximum zero suppression : Up to 90 %. Topscale

Temperature
- Minimum span : 10 °C or 10 °F
- Maximum span : 180 °C or 324 °F
Always linear and only on mA 2.

F. Contact Outputs
- General : All contacts are SPDT contacts
LED indicators for all contacts (S1, S2 and S3 LED on if the relay is powered) (S4 LED on if the relay is not powered).
- Switch capacity : 100 VA maximum at 250 VAC, 5 A
50 W maximum at 250 VDC, 5 A.
- Alarm contacts : 3 independent process alarm or control contacts (S1, S2 and S3) for conductivity or temperature value.
1 contact S4 for conductivity or fail.

Conductivity alarm	:	Adjustable hysteresis and delay time Proportional duty cycle control with adjustable proportional range, pulse period and fixed minimum/maximum duty cycle. Proportional frequency control with adjustable proportional range and pulse frequency.
Temperature alarm	:	Adjustable hysteresis and delay time.
Fail contact	:	Signals a fail of the measuring loop.
G. Logbook	:	For storing measuring/setup data.
H. Power supply Model ISC402G	:	115 VAC (± 15 %), 50/60 Hz. 230 VAC (± 15 %), 50/60 Hz. 100 VAC (± 15 %), 50/60 Hz 24 VDC (-20 % / +30 %).
I. Power consumption	:	Maximum 10 VA for AC version Maximum 10 W for DC version

2-2. Functional specifications

A. Performance		
Linearity	:	± 0.3 % ± 0.5 µS/cm ± 0.02 mA.
Repeatability	:	± 0.2 % ± 0.5 µS/cm ± 0.02 mA.
Accuracy	:	± 0.5 % ± 0.5 µS/cm ± 0.02 mA.
Influence of ambient temperature changes	:	± 0.1 % FS per °C.
Step response	:	Less then 3 seconds for 90% within two decades.
B. Temperature compensation	:	Automatic between -10 and 130 °C (10 to 270 °F).
C. Reference temperature	:	User programmable 0 to 100 °C (30 to 210 °F).
D. Temperature compensation algorithm	:	User selectable
NaCl	:	According to IEC 746-3 tables.
Alpha	:	0.00% to 3.50% per °C (°F) User programmable or 2 point calibration.
Specific process liquids	:	User selectable matrix as a function of concentration and temperature. User programmable matrix as a function of concentration and temperature.
E. Sensor diagnostics	:	Abnormal temperature. Abnormal value.

2-3. Environment and operational conditions:

A. Ambient operating temperature : -10 to + 55 °C (10 to 131 °F)
Excursions to -30 °C (-20 °F) do not influence the current output function and excursions to +70 °C (160 °F) are acceptable too.

B. Storage Temperature : -30 to 70 °C (-20 to 160 °F).

C. Relative humidity : 10 to 90 %.

D. Weather protection : Rain and dust tight to IP 65 (NEMA 4X).

E. Data protection : Non volatile memory (EEPROM)
Backup for logbook
Battery powered Date/Time backup.

F. Watchdog timer : Checks microprocessor.

G. Automatic safeguard : Continues measurement if no key is pushed for 10 minutes.

H. Voltage supply interruption : At the nominal voltage
-Less than 50 ms, no effect
-Greater than 50 ms, reset.

I. Power down : No effect, reset to measurement.

J. Operation protection : 3 digit pass code.

2-4. Construction

A. Display : Custom liquid crystal display.
Main display : $3\frac{1}{2}$ digit, 12.5 mm high.
Message display : 6 alphanumeric characters, 7 mm high.
Special fields : Flags for status indication
-HOLD, Hold output signal condition
-FAIL, Fault condition.
Measuring units: µS/cm; mS/cm.
Key prompts : YES, NO, ▲, ▶, ENT. Menu pointer (▶).

B. Keys : 6 keys operated through flexible window with tactile feedback and one hidden key behind the front cover.

C. Relay status indication : 4 red LEDs.

D. Housing

Material : Cast aluminium with a chemically resistant coating. Cover fixing, stainless steel screws in stainless steel inserts.

Window : Flexible Poly-carbonate.

Colour : Cover, Moss green.
Case, Off-white.

Cable entries : Six polyamide glands $\frac{1}{2}$"

Cable terminals : For maximum 2.5 mm^2 cable (cable finishing preferred).

E. Mounting configurations : Universal mounting kit available as an option for wall and pipe mounting. Separate mounting kit available as an option for panel mounting. Suitable for DIN sized panels 144 x 144 mm (5.67 x 5.67 inch).

F. Shipping details
Dimensions (wxhxd) : 144 x 144 x 132 mm (5.7 x 5.7 x 5.2 inch).
Package (wxhxd) : 290 x 225 x 170 mm (11.5 x 8.9 x 6.7 inch).
Weight : Approximately 2.5 kg (5 lb).

2-5. Regulatory compliance

- EMC : Meets council directive 89/336/EEC.
- Emission : Meets EN55022 Class A
- Immunity : Meets EN50082-2
- Low voltage : Meets council directive 73/23/EEC
- Installation : Designed for installation conforming to IEC 1010-1 Category II.

2-6. Model and suffix codes

Model	Suffix code	Option code	Description
ISC402G	.....	.....	Inductive Conductivity Transmitter
	-E	.....	Always E
Supply voltage	-1	.....	115 V, 50/60 Hz
	-2	.....	230 V, 50/60 Hz
	-4	.....	24 V DC
	-5	.....	100 V, 50/60 Hz
Instruction manual		E	English *
Options		/U	Pipe- and wall mounting hardware
		/PM.....	Panel mounting hardware
		/Q	Quality certificate
		/SCT	Stainless steel tag

* For other languages, please contact your local sales organization

3. INSTALLATION AND WIRING

3-1. Installation and dimensions

The EXA ISC402G should only be used in conjunction with apparatus which meets the relevant IEC, American or Canadian standards. Yokogawa can accept no responsibility for the misuse of this equipment.

3-1-1. Installation site

The transmitter is a rain-tight type, and it can be installed inside or outside. It should, however, be installed as close as possible to the sensors to avoide long cable lengths between sensors and transmitter.
Select an installation site where:

- Mechanical vibrations and shocks are negligible
- No relay/power switches are in the direct environment
- The transmitter is not mounted in direct sunlight and severe weather conditions
- Maintenance activities are possible (no corrosive atmospheres).

The ambient temperature and humidity of the installation environment must be within the limits of the instrument specifications.

3-1-2. Mounting methods

The EXA ISC402G transmitter has universal mounting possibilities:

- Panel mounting using optional brackets
- Surface mounting on a plate (by bolts from the back)
- Wall mounting on a bracket (e.g.thick brick wall)
- Pipe mounting using a bracket on a horizontal or vertical pipe (nominal diameter 50 mm).

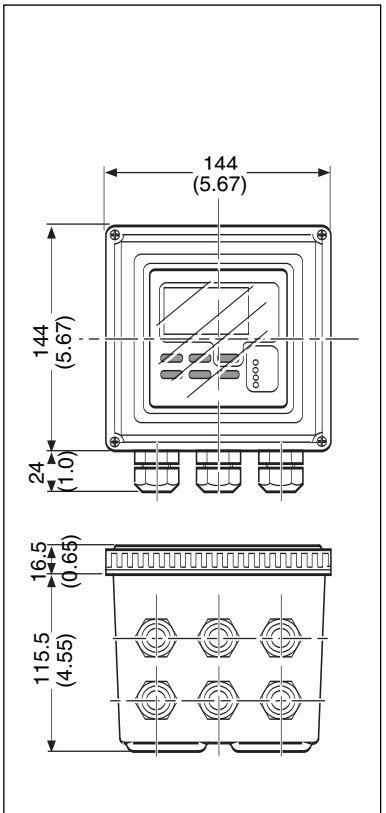


Figure 3-1. Housing dimensions and layout of glands

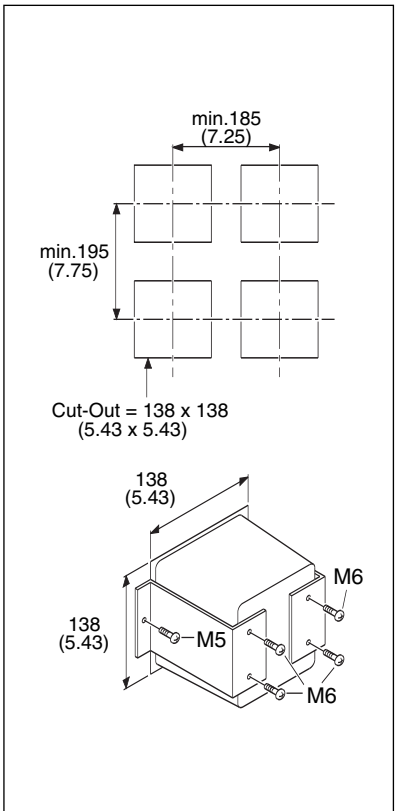


Figure 3-2. Panel mounting diagram

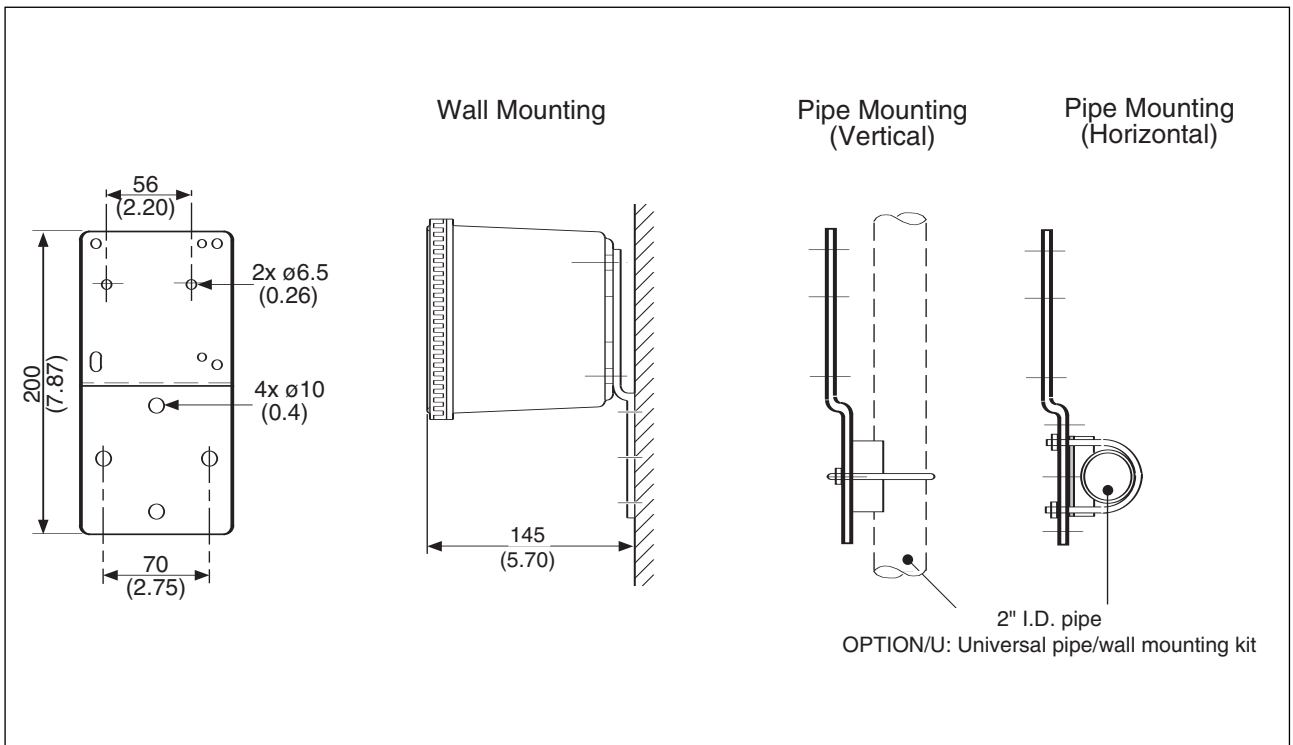


Figure 3-3. Wall- and pipe mounting diagram

3-1-3. Installation of the sensor

The ISC40G is a doughnut shaped sensor. Ideally, the process flows through the hole of the doughnut with the temperature compensator up-stream. For minimal obstruction of the flow and for accurate measurement without the need for calibration of the installation factor, the process will flow freely around the doughnut, allowing a minimum distance of 25 mm (1 in) between doughnut and process piping (d).

The sensor is provided with a gasket and retaining nut. This allows "bulkhead mounting" in tank wall or standard flange through a hole of 27 mm (1.1 in) diameter (A). The insertion is 125 mm under the flange.

Two flats are provided with wrench size 20 mm (0.8 in) to allow easy mounting and alignment of the sensor. The model identification on one flat aligns with the "up-stream" position of the sensor.

- For On-line mounting, adapters are available for standard 2 inch process connection (Gas thread, NPT, ANSI-flange, DIN-flange).
- for by-pass measurement, flow fittings are available in Polypropylene, Polyvinylidene Fluoride and Stainless Steel.
- for measurements in open ducts or vessels, immersion fittings in CPVC and Stainless Steel are available.

For easy wiring the sensor must be located within 5/10 m (16/32 ft) from the transmitter using the integral sensor cabling (refer to fig. 3-4).

Unit: mm (inch)

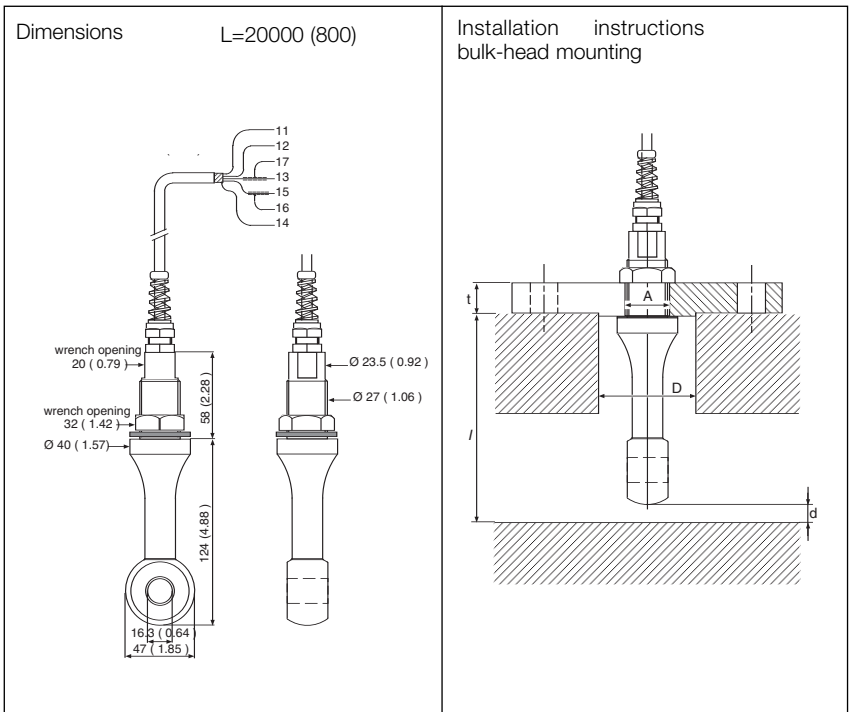


Figure 3-4.

3-2. System configuration

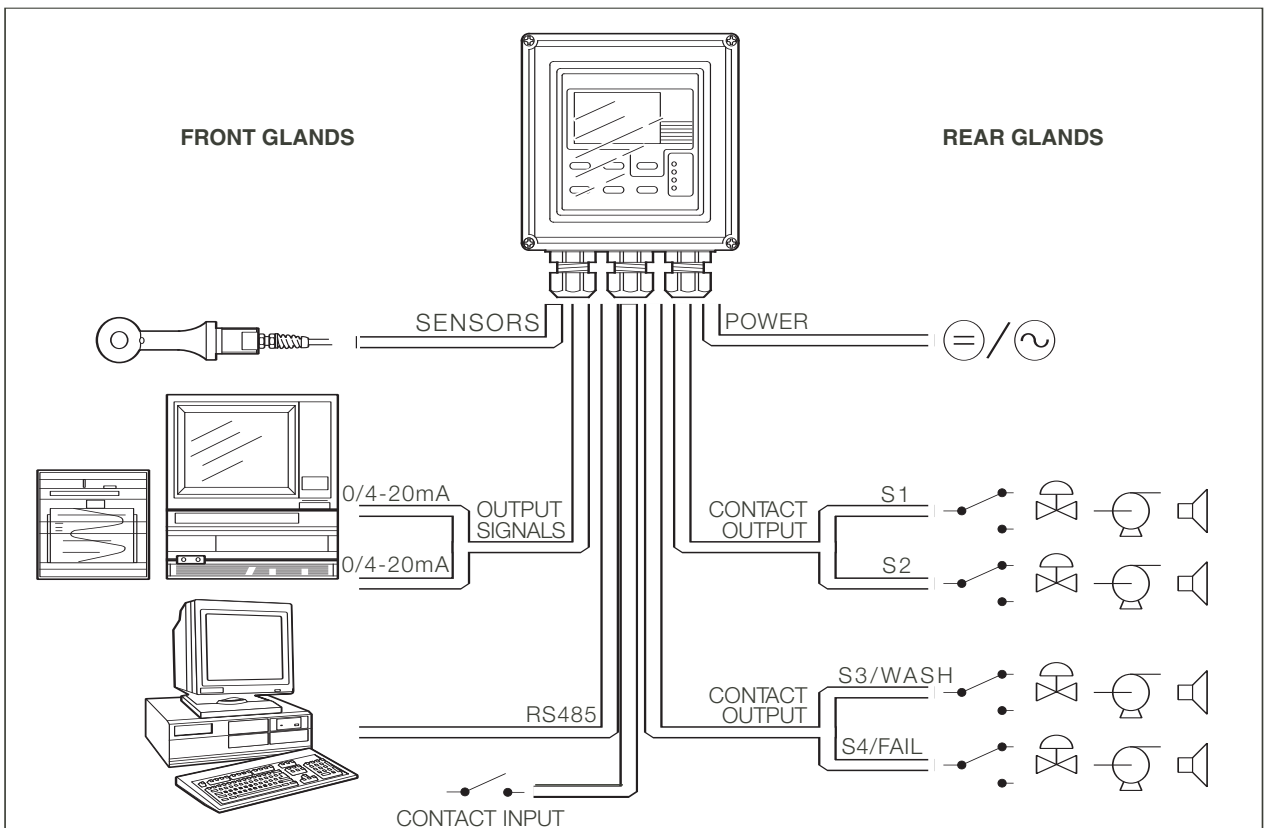


Figure 3-5.

IM 12D8C2-E-E

3-3. Wiring
3-3-1. Preparation

The relay contact terminals and power supply connections are under the screening plate. These should be connected first. Connect the input, output and databus connections last.
The procedure to open the EXA ISC402G is described below:

1. Loosen the four captive screws and remove the cover.
2. Use the rubber knob and swing open the display board to the left.
3. The upper terminals strip is now visible.
4. Remove the screen plate covering the lower terminal strip.
5. Connect the power supply and contact outputs (refer to §3-3-2 and §3-3-4). Use the three glands at the back to guide the cables out, (refer to figs. 3-7 and 3-9).
6. Replace the screen plate over the lower terminals.

WARNING: ALWAYS REPLACE THE SCREEN PLATE OVER THE POWER AND CONTACT OUTPUTS TO AVOID INTERFERENCE.

7. Connect the analog output, the sensor input and if necessary the RS485 serial bus. Refer to §3-3-4 and §3-3-5. Use the front two glands, (refer to figs. 3-7 and 3-9).
8. Close the display board and switch on the power. Commission the instrument as required or use the default settings.
9. Replace the cover and secure with the four screws.

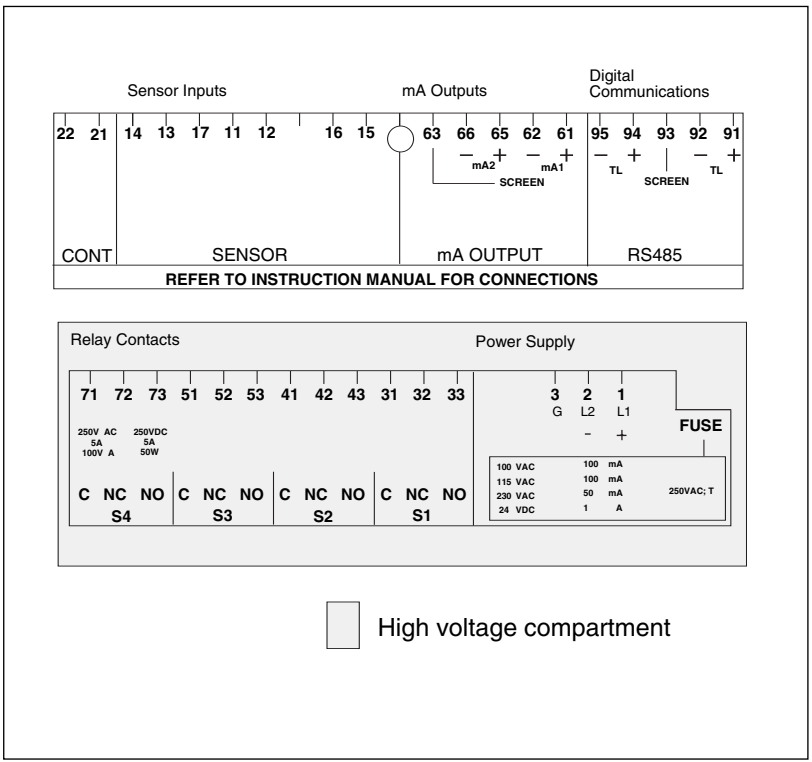


Figure 3-6. In- and output connections

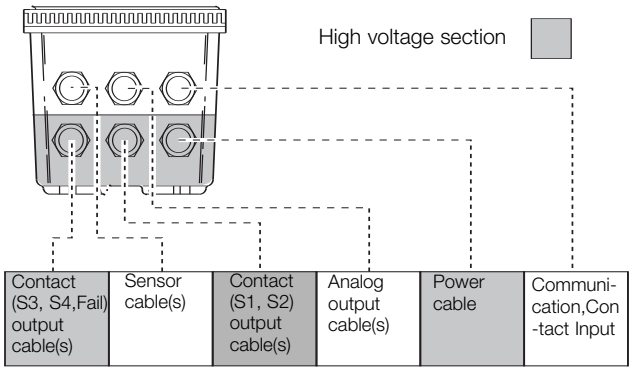


Figure 3-7. Glands for cabling

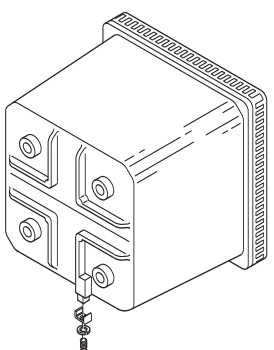


Figure 3-8. Grounding the housing

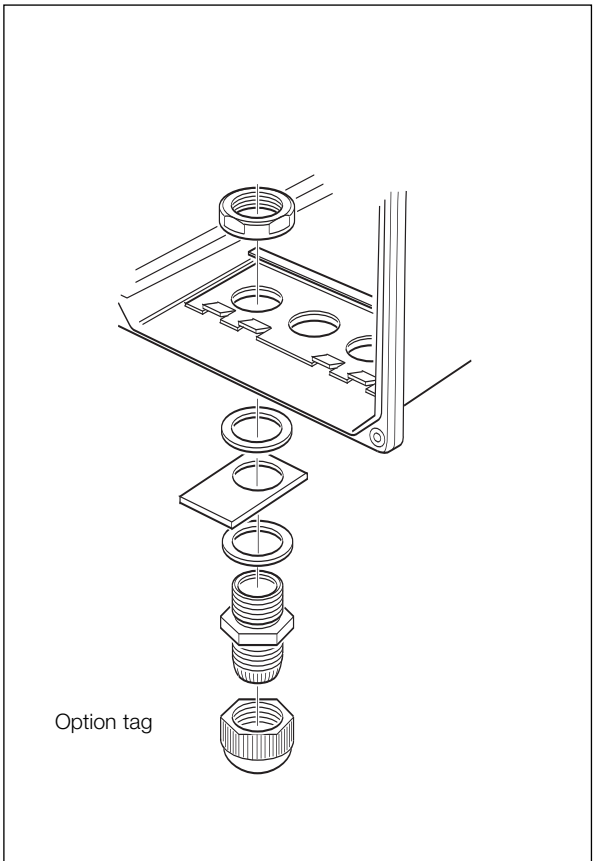


Figure 3-9. Cable glands

3-3-2. Wiring of power supply

3-3-2-1. General precautions

Make sure the power supply is switched off. Make sure that the power supply is correct for the specifications given. Remove the front cover by unscrewing the 4 captive screws. Check the type-plate on the instrument for the correct supply voltage.

Local health and safety regulations may require an external circuit breaker to be installed. The instrument is protected internally by a fuse. The fuse rating is dependent on the supply to the instrument, The 250VAC fuses should be of the "time-lag" type conforming to IEC127.
230 VAC - 50 mA, 100 VAC - 100 mA
115 VAC - 100 mA, 24 VDC - 1.0 A
The internal fuse is located next to the power terminals.

All cables connected to the ISC402G should conform the following standard:
Outside diameter between 7 to 12 mm (9/32" to 15/32")
Conductor diameter between 0.13 mm^2 to 4mm^2 (26 AWG to 12 AWG).

3-3-2-2. Access to terminal and cable entry

The terminals 1, 2 and 3 on the bottom terminal strip are used for the power supply. Guide the power cable through the gland closest to the power supply terminals. The terminals will accept wires of 4 mm^2 maximum. Use cable finishings if possible. Connect the wires as indicated in the wiring diagram (refer to Fig. 5).

AC power:
Connect terminal 1 to the phase line of the AC power and terminal 2 to the zero line. Terminal 3 is for the power ground. This is separated from input ground by a galvanic isolation. The size of conductors should be at least 1.25 mm^2, with an outer diameter of 7 to 12 mm.

DC power:
Connect terminal 1 to the positive outlet and terminal 2 to the negative outlet. Terminal 3 is for the power ground. This is separated from input ground by a galvanic isolation. A 2-core screened cable should be used with the screen connected to terminal 3. The size of conductors should be at least 1.25 mm^2, with an outer diameter of 7 to 12 mm.

3-3-2-2a. Grounding the housing, refer to fig. 3-7

To protect the instrument against interference the housing should be connected to ground by a large area conductor. This cable can be fixed to the rear of the housing using a braided wire cable with a lug. Put a serrated lock washer under the lug to improve the contact to the housing.

3-3-3. Switching on the instrument

After all connections are made and checked, the power can be switched on from the power supply. Make sure the LCD display comes on, all segments will light up and then the instrument will display a value. If errors are displayed or a valid conductivity value is not shown, consult trouble shooting, refer to §8-1, before calling Yokogawa.

3-3-4. Wiring the contact signals

3-3-4-1. General precautions

The contact output signals consists of voltage-free relay contacts for switching electrical appliances (SPDT). They can also be used as digital outputs to signal processing equipment (e.g. PLC).

It is possible to use multi-core cables for the contact in-and output signals and screened multi-core cable for the analog signals.

3-3-4-2. Contact outputs

The 4 contact outputs can be wired to your own requirements, refer to Fig. 3-7.
In the Non-Alarm or Power Off states, contacts S1, S2 and S3 are OFF, Common (C) and Normally Closed (NC) are in contact.
In the "Fail" or Power Off states, contact S4 is ON, Common (C) and Normally Closed (NC) are in contact. You can either use them to switch AC power, or switch a DC Voltage for digital interfacing.

The contact S1 is pre-programmed for high alarm function.
The contact S2 is pre-programmed for a low alarm function.
The contact S3 is not activated as an alarm (off).
The contact S4 is programmed for FAIL.

These four contacts can be used for simple process control by programming their function in §7-7.

The FAIL contact is programmed to signal a fault in the measuring loop.

Always connect the FAIL-contact to an alarm device (e.g. lamp, signal horn, alarm panel) to make use of the fault detection possibilities of the EXA transmitter.

3-3-5. Wiring the analog output signals

3-3-5-1. General precautions

The analog output signals of the EXA ISC402G transmits low power standard industry signals to peripherals like control systems or strip-chart recorders, refer to Fig. 3-4.

3-3-5-2. Analog output signals

The output signals are either 0 to 20 mA or 4 to 20 mA. The maximum load can be 600 ohms.

It is highly recommended to use shielding on the output signal cables. Terminal 63 is used to connect the shielding.

3-4. Wiring the sensor

3-4-1. General precautions

The sensor cable transmits low voltage, high frequency signals and should be installed separately from any high voltage, high current and/or power switching cables. This to avoid any unintentional cross talk or other kind of interference of the conductivity measurement.

3-4-2. Connecting the sensor cable to the transmitter

1. To access terminals remove the front cover of the EXA ISC402G by releasing the 4 captive screws.
2. Loosen the cable gland and pull the cable in the connection compartment.
3. The sensor leads are numbered and the leads must be connected to the terminals with the corresponding number, refer to Fig. 3-4:
   - the temperature compensator with 11/12
   - the drive coil with 15/16
   - the receive coil with 13/17.

   Terminal 14 is for connection of the shield.
4. Screw the cable gland tight to ensure IP65 (NEMA 4) environmental protection. An optional protection hose (flexible conduit) is available for additional mechanical protection of the sensor cable.

4. START-UP

The EXA ISC402G transmitter offers great flexibility to let the user have one hardware version for a multitude of different applications.

The software has been programmed for a "general application". It will be necessary for the user to program the instrument to his specific requirements or application.

Although programming the transmitter is simple, some preparation is necessary. This chapter will assist the user in recognizing the superb flexibility of the transmitter and making the best use of it's capabilities.

4-1. The DISPLAY functions

4-1-1. The primary display

The primary display is a $3^1/_2$ digit display that indicates the measured value. It is also used to display the variables that can be adjusted in the different programming steps. Generally, the "SHIFT" **>** key changes the digit to be changed with the "UP" **^** key. When the period symbol (.) is flashing the "UP" key will adjust the value by a factor of 10.

NOTES:

1. *The display indicates in either µS/cm or in mS/cm (1 mS/cm = 1000 µS/cm). Make sure that the correct unit is shown during range adjustments.*
2. *If the prompt flag is flashing and no digit nor period is flashing, then the "UP" key will present the "1" and allows user to change from 3 to 4 digits value.*

4-1-2. The secondary display

The secondary display is a "message" display. It will indicate a description of the variable that can be adjusted during programming, it allows display of a second variable during normal measurement:

- Type of Temperature Compensation (Output 1)
- Compensated SC (Output 2)
- Type of Temperature Compensation (Output 2)
- % Concentration (Output 1)
- % Concentration (Output 2)
- Temperature
- mA 1
- mA 2
- Installation Factor (I.F.)
- Reference temperature
- Software release.

It will also, if relevant, display error codes.

4-1-3. Annunciators

The custom made display will also show relevant messages as shown on the inside cover of this manual.

4-2. The Output (RANGE) functions

The following output functions are possible:

4-2-1. Output linear to conductivity

This is the most common output function and it is described in §6-2 "Output range adjustment".

4-2-2. Output linear to concentration

When the conductivity system is used as concentration analyzer, the ISC402G can be programmed to have the output current linear to concentration. This is described in §7-6 "Output table for non-linear range". The concentration can also be read as % by weight on the LCD message display. This is described in §7-3. "Percent by weight indication on second display line".

4-2-3. Output linear to temperature

mA 2 may be configured as a linear temperature output. This is described in §6-2 and §7-5.

4-2-4. Contact Input

mA 1 and mA 2 will be swapped if the Input contact is closed.

4-3. Temperature (TEMP) compensation

The factory adjustment for automatic temperature compensation is the standardized NaCl algorithm according IEC 746-3.
For concentrated electrolytes this may not be accurately compensate for process temperature variations.
The ISC402G gives the user 4 methods of optimizing the temperature compensation:

4-3-1. Field calibration of (linear) temperature compensation

The procedure is described under §6-4.

4-3-2. Programming of calculated temperature coefficient

This procedure is described in §7-13.

4-3-3. Selection of preprogrammed electrolyte solutions

For Sulphuric Acid, Nitric Acid, Hydrochloric Acid and Sodium Hydroxide, Yokogawa has defined standard ranges (see §7-23).

4-3-4. Programming of complex non-linear, conductivity dependent temperature coefficients using an easy 5x5 matrix structure

This procedure is described in §7-24.

4-4. Calibration (CAL)

The factory calibration of the ISC402G allows the user to install the system without the need for calibration. In specific situations calibration may be necessary for high accuracy.

NOTE: The factory calibration sets the I.F. (Installation factor) to a nominal 1.88. When a field calibration is performed it is the I.F. which is changed (see also sections § 4-4-2 & § 4-4-3.)

4-4-1. Air calibration/Air set

Every (new) ISC402G/ISC40 combination has to be paired prior to installation of the sensor in process.
Further the 'Air Set' routine enhances the accuracy of the measurement at very low conductivity values.
This procedure can be found in §6-5.

4-4-2. Programming of installation factor

If the doughnut is surrounded by at least 25 mm (1 in) of process, the factory adjusted installation factor (cell constant) of 1.88 gives accurate results. In narrow piping systems, the user can program different factors according to the instructions in §7-2.

4-4-3. Calibration using a sample

Using an accurate reference standard such as the Yokogawa Model SC82 Personal Pocket Conductivity Analyzer, the user can perform a 1 point calibration according to the instructions in §5-1.

4-5. The contact output functions

Contact S1 and S2 defaults are set to high and low alarm respectively.
Contact S3 is not activated.
S4 is set to "FAIL"

To change the allocation of the contacts refer to service codes 08-11.
To change the characteristics of the contacts, refer to service codes 15 and, if proportional control functions are required, to service codes 12-14.

4-6. Operations overview

	Routine	Use	Chapter
MAINTENANCE Operation by keys through the closed cover	CAL	Calibration	5-1
	DISPLAY	Show or fix additional values	5-2
	HOLD	Switch HOLD function ON or OFF	5-3
	SETPOINTS	Adjust the setpoints (when activated)	5-4
COMMISSIONING Operation by * key when cover is removed	SETPOINTS	Activating or adjusting the setpoints for the output contacts	6-1
	RANGE	Adjusting the output ranges	6-2
	SET HOLD	Activating the hold function	6-3
	TEMP	Temperature compensation adjustment	6-4
	AIRSET	Zero calibration before start-up	6-5
SERVICE Operation by coded entry from commissioning	SERVICE	Fine tuning the performance	7

NOTE: All three levels can be separately protected by a passcode. See §7-27

4-7. Cleaning

If it is necessary to clean the outside of the EXA housing, this should done using only a soft cloth and household detergent. DO NOT USE corrosive or abrasive cleaners.

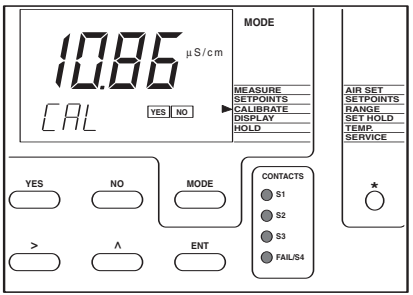
4-8. Battery

The EXA instrument contains a lithium cell to support the clock function when the power is switched off. This cell needs to be replaced at 5 yearly intervals (or when discharged). Contact your nearest Yokogawa service centre for spare parts and instructions.

5. CONFIGURATION IN MAINTENANCE MODE

5-1. CALIBRATION

1. ACCESS TO CALIBRATION ROUTINE



MODE Press MODE-key for access to maintenance mode

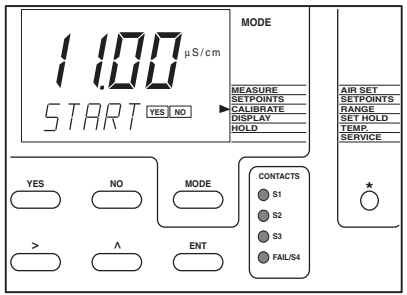
Select calibration routine

NO Press NO-key until the display indicates CAL

CAL = Calibration

YES Confirm selection by pressing YES-key. The display will indicate START

2. ADJUST VALUE



START = Start calibration

YES Conform start of adjustment by pressing YES-key

Adjust process value to a previously determined (e.g. taken from a hand-held conductivity meter)

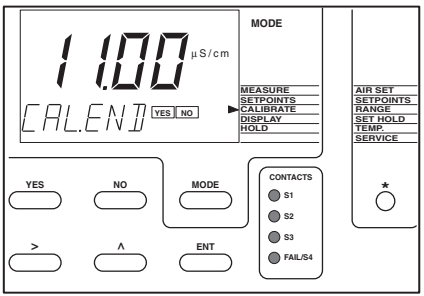
> Select digit to adjust

^ Adjust value

ENT Conform adjusted value

NO Stop calibration

3. END CALIBRATION



WAIT = Entering adjusted value.
Error E3 indicates that the calibrated cell installation factor is outside the acceptable limits (0.2 - 20 I.F.)

CAL.END = End of calibration session

YES Calibration is finished after pressing YES-key. Return to measuring mode

NO By pressing NO-key there is a re-start (repeat step 2)

MODE ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

5-1. CALIBRATION

1. When is calibration necessary?
Initially follow the procedure given in item §4-4-1 for air calibration when setting up the instrument for the first time.

Calibration of conductivity instruments is not normally necessary as the conductivity cells are manufactured to close tolerances and do not alter in use.

If the cell has severe fouling or been subject to abrasion (possibly during cleaning) it may be necessary to calibrate.

Alternatively calibration may be carried out with a simulator to check the electronic circuits and the sensor.

Since the ISC402G/ISC40 inductive conductivity system measures the conductivity of the "liquid winding" through the doughnut, part of this "measuring cell" is outside the doughnut. If there is little space between doughnut and process piping, calibration with a sample of the process fluid is necessary to ensure accurate measurement.

2. How is calibration done?
Calibration is carried out by measuring a solution which has known conductivity and adjusting the instrument to show the correct conductivity value.

The calibration can be achieved using one of two methods:

A calibration solution can be prepared in the laboratory. A salt solution is prepared with a known precise concentration.

The temperature is stabilized to the reference temperature of the instrument (usually 25 °C). The actual conductivity value of the solution is taken from tables. To calibrate the instrument, the sensor is removed and suspended in the solution, the conductivity value is then entered from the tables and the calibration routine completed.

Make sure the sensor does not touch the sides of the container, refer to Fig. 5-1.

Alternatively the instrument can be calibrated using the process solution measured with a standard instrument. Care must be taken to make the measurement at the reference temperature since differences in the type of temperature compensation of the instruments may cause an error.

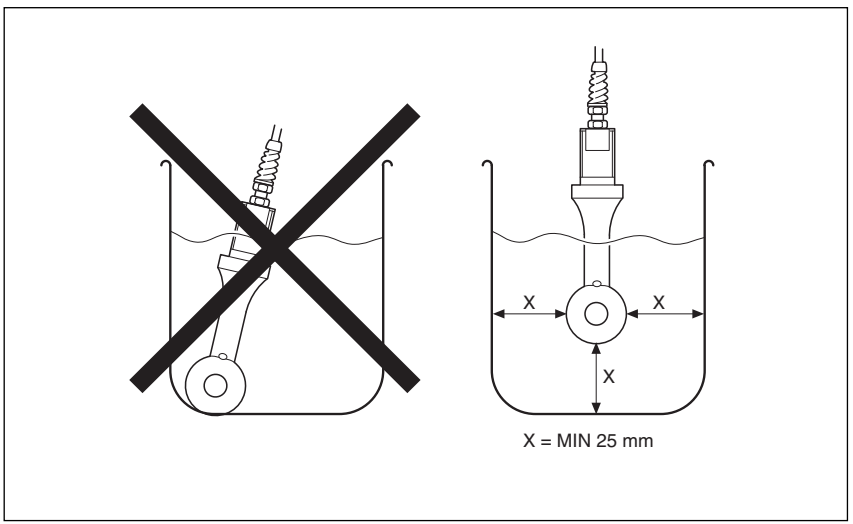


Figure 5-1. Sensor in calibration solution

With this method the sensor is not removed from the process. This method is the most convenient method of calibrating the ISC402G transmitter. Since the sensor is immersed in the process, errors caused by installation characteristics are compensated for.

NOTE: The standard instrument used as reference method must be accurate. Yokogawa recommends that the Model SC82 pocket conductivity meter be used for this purpose.

3. Typical calibration solutions

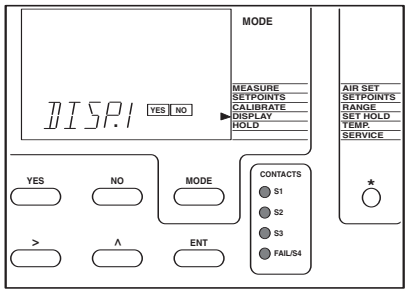
Table 5-1 below shows typical conductivity values for solutions which may be made up in the laboratory.

Table 5-1. NaCl at 25 °C

%weight	mg/kg	Conductivity
0.001	10	21.4 µS/cm
0.003	30	64.0 µS/cm
0.005	50	106.0 µS/cm
0.01	100	210.0 µS/cm
0.03	300	617.0 µS/cm
0.05	500	1.03 mS/cm
0.1	1000	1.99 mS/cm
0.3	3000	5.69 mS/cm
0.5	5000	9.48 mS/cm
1.0	10000	17.6 mS/cm
3.0	30000	48.6 mS/cm
5.0	50000	81.0 mS/cm
10.0	100000	140.0 mS/cm

5-2. SELECTING A VALUE TO DISPLAY

1. ACCESS DISPLAY 1 OR DISPLAY 2



DISP.1 /DISP.2 = Display routine

MODE Press MODE key for access to maintenance mode

Select display DISP.1 or DISP.2 routine

NO Press this key until DISP.1 or DISP.2 is shown.

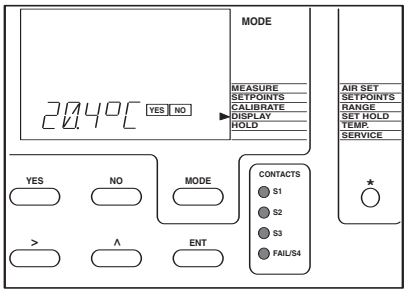
DISP=Display routine

YES Confirm selection of DISP.1 or DISP.2 by pressing YES-key when the required display is shown.

Continue with step 2 for DISP.1 parameters.

Continue with step 3 for DISP.2 parameters.

2. SELECT DISPLAY 1 PARAMETERS



Display will show temperature compensation method

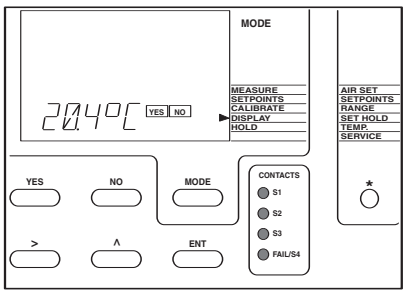
NO Press NO-key to change parameter to be displayed.

Parameter
- TC type 1
- % concentration 1 (if activated in §7-3)
- Temperature
- Output signal 1
- Output signal 2
- Installation factor
- Reference temperature
- Software release
- DISP.1

YES Press the YES-key to confirm the required parameter to be displayed.

MODE Return to measure

3. SELECT DISPLAY 2 PARAMETERS



Display will show compensated conductivity value 2

NO Press NO-key to change parameter to be displayed.

Parameter
- Compensated SC type 2
- TC type 2
- % concentration 2 (if activated in §7-3)
- Temperature
- Output signal 1
- Output signal 2
- Installation factor
- Reference temperature
- Software release
- DISP.2

YES Press the YES-key to confirm the required parameter to be displayed.

MODE Return to measure

MODE ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

5-2. SELECTING A VALUE TO DISPLAY

1. What is a display routine?
The second line of the display is to show:
- Actual status
- Messages
- Errors.

When delivered from the factory the EXA ISC402G shows the temperature on the second line.

You can make the instrument show a different parameter on the second line by selecting it from the list on the right.

NOTE: DISP.2 is only activated when % concentration or Temp. comp. type are set differently for each mA output.

2. What can you read?

- Type of Compensation output (Output 1)	is programmed
- Compensated SC (Output 2)	is an actual value
- Type of Temperature Compensation (Output 2)	is programmed
- % Concentration (Output 1)	is an actual value
- % Concentration (Output 2)	is an actual value
- Temperature	is an actual value
- mA 1	is an actual value
- mA 2	is an actual value
- Installation Factor (I.F.)	is programmed
- Reference temperature	is programmed
- Software release	pre-programmed value

The choice of temperature units is done from the Service level.

Error messages have priority over other messages.

NOTE: Percent by weight is only visible when activated from the service level §7-3.

3. Example
To check the value of the output signal (4 to 20 mA), it is shown on the second line of the display.

Measuring range	0 to 100 µS/cm
Output signal	4 to 20 mA
Process value	60 µS/cm
Output value	13.6 mA

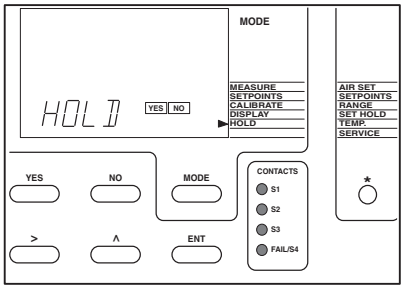
When the second line is changed to display output the current signal is visible all the time.

Whenever HOLD is activated the value on the display is frozen to the programmed value (using the FIXED setting).

Pressing MODE will return the instrument to the measure mode and the temperature will be displayed again.

5-3. USE OF HOLD FUNCTION

1. ACCESS TO HOLD ROUTINE



NOTE: This function can only be used if activated during commissioning (see §6-3).

MODE Press MODE-key for access to maintenance mode

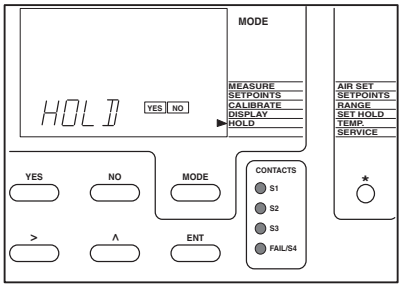
Select HOLD-routine

NO Press this key until the display indicates HOLD

HOLD=Hold output function

YES Confirm selection by pressing YES-key. Display will blink both HOLD and YES/NO

2. SWITCH HOLD ON/OFF



Make selection the switch HOLD on or off

NO Switch hold OFF by pressing NO-key

YES Switch hold ON by pressing YES-key

HOLD in the left top corner of the display is indicated.
If HOLD is ON alarms and control cannot be activated.

MODE ESCAPE TO MEASUREMENT can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

5-3. USE OF HOLD FUNCTION

1. What is HOLD?
Hold is a function which freezes the output signal temporarily, it is normally used during maintenance to prevent unwanted controller reaction when the cell is removed from the solution being measured.

The HOLD function must be commissioned from the programming menu before it can be switched on or off. See commissioning the hold function for more details.

NOTE: AUTO RETURN will switch off HOLD after 10 minutes, see §7-10.

2. How does it work?
From this level the HOLD function can only be switched ON or OFF.

HOLD is switched on when you press YES when HOLD and YES/NO are blinking. When you press NO hold will be switched off.

A flag is kept in memory and an indication is made in upper left corner of the display field.

The HOLD function only influences the output signal, no other functions are influenced.

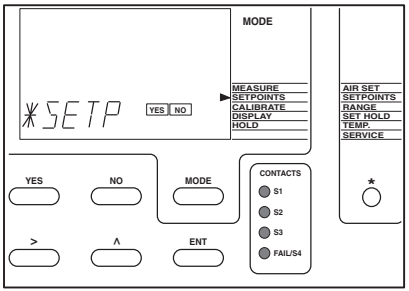
The operator is prompted to switch HOLD on or off after having performed a maintenance function.

3. Example
During the transfer of cleaning liquid into a batch reactor with a conductivity-control system, the HOLD function is switched ON to prevent the controlling instruments from running wild.

After cleaning has ceased and the new batch has been started HOLD is switched OFF again and conductivity control resumes.

5-4. ADJUSTING THE SET POINTS

1. ACCESS TO SET POINTS MENU



NOTE: This function can only be used if activated during commissioning (See §6-3 and §7-18).

MODE Press MODE key for access to maintenance mode.

Select setpoints menu for contact outputs

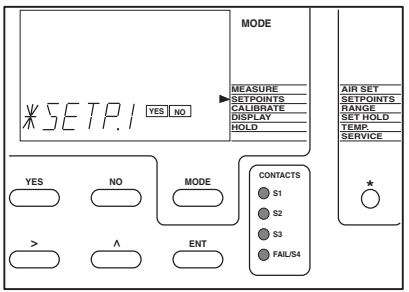
NO Press NO-key until SETP is indicated

SETP = Set points menu

YES Confirm selection by pressing YES-key.

The display will indicate SETP1

2. SELECT SET POINT TO ADJUST



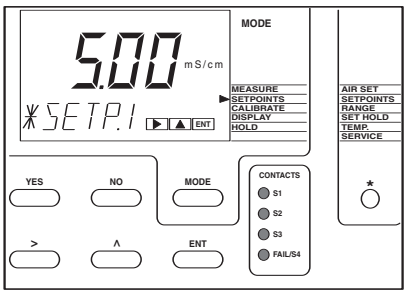
Display will show *SETP1

YES / **NO** Press YES-key to adjust set point S1 or press NO-key to change to required setpoint and after that the YES-key.

NOTE: Only those setpoints activated will be displayed, (refer to §7-18).

The message display will indicate the parameter to which the contact is allocated SC (conductivity) or T °C/°F (temperature).

3. ADJUST THE SET POINT VALUE



The display indicates the actual setting in engineering units. This setting can be changed using keys:

> Select digit to adjust

^ Adjust value

ENT Confirm adjusted value

Continue routine to calibrate second point (repeat step 2).

MODE Return to measurement mode.

See notes on page 27.

MODE ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing). Answer YES or NO or MODE again to return to measurement.

NOTE: It is only possible to access this function at the maintenance level if it has been activated with service code 24.

This function gives the operator the facility to change the setpoints at the maintenance level. It can only be used if it has been activated in service code 24. The protection of the set points is to prevent unauthorized access to these functions.

NOTE:
1. SETP1, SETP2, SETP3 or SETP4 will only be displayed if the appropriate contact output has been activated, (refer to §7-18).
2. If no contact output has been activated, this item will be skipped.

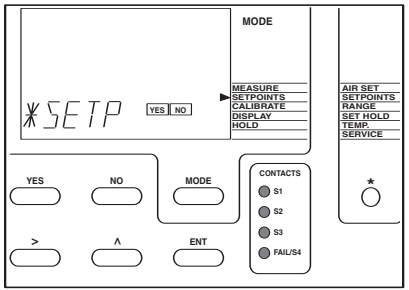
5-4. ADJUSTING THE SET POINTS

NOTE:
SETP1 is for the contact output marked S1 and is programmed as a high alarm for conductivity (default). SETP2 is for the contact output marked S2 and is programmed as a low alarm for conductivity (default). SETP3 is for the contact output marked S3 and not activated (default).
SETP4 is for the contact output marked S4 and is programmed for FAIL (default).

To change the functioning of the output contacts refer to §7-7 and §7-8. SETP1 is set by default at 1.000 mS/cm, SETP2 is set by default at 10 µS/cm, SETP3 is set by default to OFF and SETP4 is set by default to FAIL.

6. CONFIGURATION IN COMMISSIONING MODE

1. ACCESS TO SET POINTS MENU



Remove cover by releasing 4 screws

⊗ Press this key for access to commissioning mode

Select setpoints menu for contact outputs

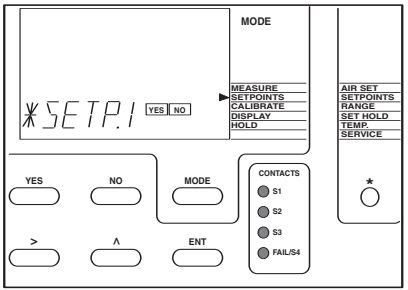
NO Press NO-key until SETP is indicated

SETP = Set points menu

YES Confirm selection by pressing YES-key.

The display will indicate SETP1

2. SELECT SET POINT TO ADJUST



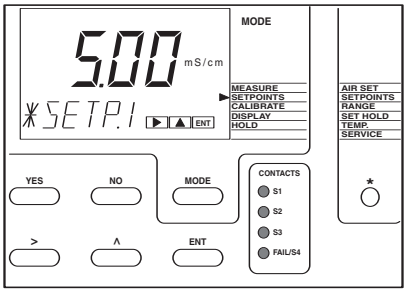
Display will show *SETP1

YES / **NO** Press YES-key to adjust set point S1 or press NO-key to change to required setpoint and after that the YES-key.

NOTE: Only those setpoints activated will be displayed, (refer to §7-18).

The message display will indicate the parameter to which the contact is allocated SC (conductivity) or T °C/°F (temperature).

3. ADJUST THE SET POINT VALUE



The display indicates the actual setting in engineering units. This setting can be changed using keys:

> Select digit to adjust

^ Adjust value

ENT Confirm adjusted value

Continue routine to calibrate second point (repeat step 2).

MODE Return to measurement mode.

NOTE: Relay energized state.

See notes on page 27, and service codes in §7-7, 7-8, 7-18.

MODE ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing). Answer YES or NO or MODE again to return to measurement.

6-1. ADJUSTING THE SET POINTS

1. What are setpoints?
In general the contact outputs of the EXA ISC402G can be used to signal extraordinary situations in the process.
The alarm contacts are switched if the comparison of the changes process value to a fixed setpoint meets the condition of the alarm function (higher or lower). These setpoints are programmed in this section.

One of the advantages of a micro-processor instrument is, that it is fairly simple to change the function of the contact outputs. It is possible to use the contacts for simple process control functions like proportional duty cycle or pulse frequency control.
The adjustment of the setpoints for these functions also has access from this section. The setting of the control type and parameter have access through the service level at §7-7.

The function of the FAIL contact cannot be changed. It is signalling faults in the measuring loop to e.g. a connected control panel or control room. It is recommended to always connect the FAIL-contact because it overrules all other signals from the EXA ISC402G. In addition it is possible to activate a special 22 mA signal on the output when FAIL is on (see §7-20).

2. How does it work?
As an example a description of what happens when the process value exceeds the high alarm setpoint of S1 is given below.

When the process value rises above the setpoint of S1, the delay time of the relay contact starts. After the delay time has passed the LED lights and the relay contact is switched on.
When the process value goes down again, the value must be below the setpoint minus the hysteresis. After the delay time has expired the LED and the relay are switched off.

Hysteresis (sometimes called "dead-band") and delay time are programmed from the service level, refer to §7-9 for conductivity and §7-13 for contacts allocated to temperature.
These parameters are intended to mask the effects of sudden peaks in the process value and to allow for the mechanical characteristics of solenoids.
Hysteresis works on one side of the setpoint only. For a high alarm it is below the setpoint, for a low alarm it is above the setpoint.

3. Process control with output contacts
The EXA ISC402G incorporates simple process control functions.

Differentiation is made between 3 kinds of control functions:

- On/off with the alarm function
- Proportional duty cycle control
- Proportional pulse frequency control.

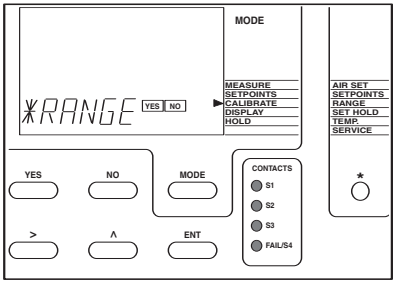
Note: The proportional control function is only applicable for contacts allocated to conductivity.

In the first case the programmable setpoint, hysteresis and delay time of the alarms gives the possibility to set up a simple control function.
The proportional duty cycle control has a programmable pulse period and a proportionally changing duty cycle. The proportional control range and pulse period must be set from the service level, refer to §7-8.
The proportional pulse frequency control changes the number of pulses between 0 and the programmed maximum number of pulses must be set in §7-8.
As all settings are in percent of proportional control range the actual linear or non-linear behaviour through an output table has no influence on the functioning of the alarm or control functions.

4. Special feature
Adjusting the setpoints can be done without opening the instrument only when access is activated in the service level with code 24, refer to §7-18).

6-2. OUTPUT RANGE ADJUSTMENT

1. ACCESS TO OUTPUT MENU



Remove cover by releasing 4 screws

⊗	Press this key for access to commissioning mode

Select RANGE menu

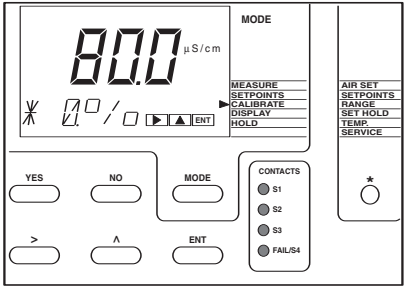
NO	Press NO-key until RANGE is indicated

RANGE = Output range adjustment

YES	Confirm selection by pressing YES-key. The display will indicate RANG.1

NOTE:
If the range to be commissioned is via a table this whole item will be skipped! Default is a linear range.

2. ADJUST START VALUE OF THE RANGE



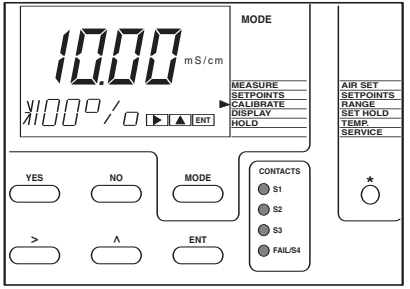
Display will show *RANG.1

YES	Press YES-key to adjust RANG.1 or press NO-key to change to RANG.2 and after that YES-key.
NO	Display will show SC in RANG.1 Display will show SC or T in RANG.2 (See §7-5 for selection of Temp on mA 2)
YES	Confirm selection

Display will show 0%
Adjust start value of the output

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value. Display indication moves to 100%

3. ADJUST THE END VALUE OF THE RANGE



Display will show 100%

Adjust full-scale value of the output

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value
MODE	Return to measurement mode

MODE	ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

6-2. OUTPUT RANGE ADJUSTMENT

1. What is the output range?
The default value of the software defines the output range of 4-20 mA = 0-1000 mS/cm.

This display will always show the full range of the instrument from 0-2000 mS/cm. Maximum resolution is achieved by auto-ranging, where the position of the decimal point and measuring units (microSiemens/milliSiemens) are moved to best fit the actual value.

For control or recording the current output can be ranged to a specific part of the total measuring span.

Linear ranges can be programmed in this routine. It is also possible to program non linear output ranges for specific applications, these are programmed in the service level, see §7-5 and 7-6.

2. Programming a linear output range
A linear output range is programmed by entering two values:

0% - the conductivity at the start of the output range which corresponds to 0.0 mA or 4.0 mA (see §7-4).

100% - the conductivity at the end of the output range which corresponds to 20 mA.

4. Related functions
The EXA ISC402 has an output table which can be programmed to give any non-linear output characteristic. Use of this table is described in §7-5. After the table has been activated the linear RANGE routine will no longer have any effect and will not be accessible in the commissioning menu.

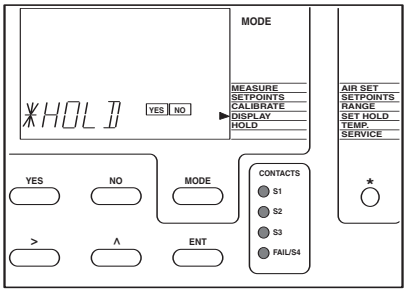
Programming of the 21 step table is described in §7-6.

The non-linear output can be used to follow a concentration curve for a specific product. Care must be taken to ensure that the temperature compensation is also set up for the measured fluid under representative conditions. It should also be noted that conductivity measurements are not specific, they can be influenced by impurities present or changes in the fluid composition.

Programming the percent by weight indication on the second line of the display is described in §7-3.

6-3. SET UP HOLD FUNCTION

1. ACCESS HOLD ROUTINE



Remove cover by releasing 4 screws

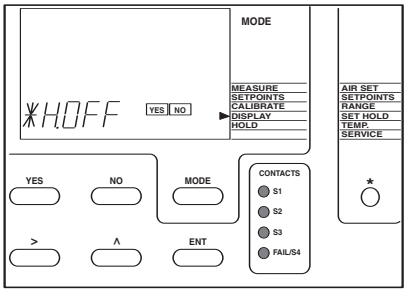
⊗	Press this key for access to commissioning mode
	Select HOLD menu
NO	Press NO-key until the display indicates HOLD

HOLD = HOLD menu

YES	Confirm selection by pressing YES-key.

The display will indicate actual status

2. SELECT SET POINT TO ADJUST



Display shows actual status
- *H.OFF = Hold not activated
- *H.ON = Hold activated

Activate (inhibit) HOLD function

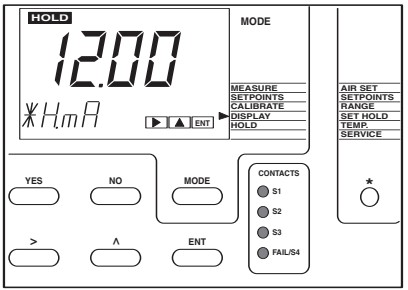
NO	Change status
YES	Confirm selection

Display shows current setting
- *H.FIX = Hold fixed value
- *H.LST = Hold last value

Select hold fixed or last

NO	Change selection
YES	Confirm selection. The display will indicate *H.mA 1 (*H.FIX) or return to measurement mode (*H.LST).

3. SET VALUE TO HOLD



The display indicates the actual setting of *H.mA 1 in milliamps. This setting can be changed using keys:

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value and change to *H.mA 2.

Adjust the value using the keys as above and press the ENT-key.

MODE	Return to measurement mode.

MODE	ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

6-3. SET-UP HOLD FUNCTION

1. What is HOLD?
HOLD is a function freezing the output signal temporary, during normal maintenance, preventing unintended alarm or colour actions to occur.

Two possibilities are generally used:
- Keep the output at the LAST (H.LST) value just before the start of maintenance. This can only be used when a recorder is connected.
- Keep the output at preset FIXED (H.FIX) value which will not cause any of the alarms to go off or any controlling action to be taken. This is the preferred situation when dealing with Conductivity-control systems.

In both situations the alarm contacts will switch off and the proportional control (if activated) will not be activated. The FAIL contact will also not be activated.

2. How does it work?
The HOLD-function has to be activated from this menu before it can be used.

The instrument will keep the output frozen during the following events:
- Access to the *-menu.
- Access to the calibration mode.
- Switching it from the MODE-menu.

HOLD is signalled in the display by a special field.

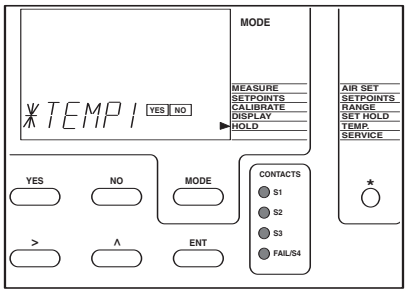
The operator is prompted to switch HOLD on or off before returning to normal measurement.

3. Application example
In a storage tank the concentration of sodium hydroxide (caustic soda) has to be kept at 5%, the mixing process is controlled by a conductivity transmitter and electromagnetic valves.
During maintenance of the conductivity cell or the transmitter the HOLD function is activated to keep the mixing process from wasting precious chemicals to the sewer.
The HOLD function is set for a fixed output so that the dosing valves will not be activated.

4. Time out
HOLD will be disabled after 10 minutes if no key is pressed. To cancel this function refer to §7-10.

6-4. TEMPERATURE COMPENSATION

1. ACCESS TEMPERATURE COMPENSATION ROUTINE



Remove cover by releasing 4 screws

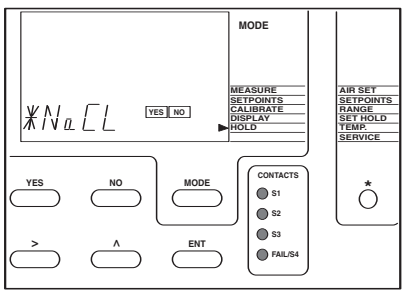
⊗	Press this key for access to commissioning mode Select temperature compensation menu
NO	Press NO-key until the display indicates TEMP 1/TEMP 2

TEMP 1 = Temperature compensation menu mA 1.
TEMP 2 = Temperature compensation menu mA 2.

YES	Confirm selection by pressing YES-key.

The display will indicate actual status

2. SELECT STANDARD OR MANUALLY SET COMPENSATION



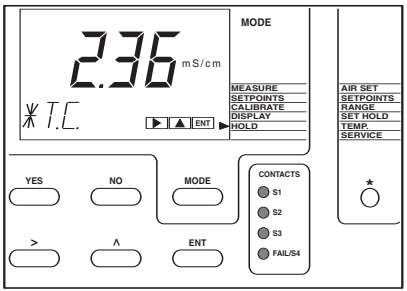
NaCl = Standard temperature compensation according to IEC tables.
MATRX = Selection or creation of programmed compensation tables via §7-23 and §7-24.
T.C = Manually set temperature compensation factor by calibration or via §7-13.

Select required temperature compensation

NO **YES**	Change status Press the YES-key to confirm the selection

NOTE: Only one output may have MATRX compensation selected, NaCl or T.C. are a free choice.
When T.C. is selected, it may be programmed in §7-13 or calibrated as follows.

3. SET THE TEMPERATURE COMPENSATION COEFFICIENT (only if T.C. is selected)



The display shows *WAIT for approximately 3 seconds and then the coefficient can be set by adjusting the conductivity value at process temperature to the predetermined value at the reference temperature, normally 25 °C.

Adjustment of the value

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value.

Error E2 indicates that the coefficient is outside the permitted limits.

MODE	Return to measurement mode.

MODE	ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

6-4. TEMPERATURE COMPENSATION

1. Why is temperature compensation necessary?

The conductivity of a solution is very strongly influenced by temperature. Typically for every 1 °C change in temperature, the solution conductivity will change by approximately 2%.
The effect of temperature varies from one solution to another and is determined by several factors; solution composition, concentration and temperature range.
A coefficient (α) is used to express the amount of temperature influence in % change in conductivity/°C.
In almost all applications this temperature influence must be compensated before the conductivity reading can be interpreted as an accurate measure of concentration or purity.

Table 6-1. NaCl compensation according IEC 746-3 with T_{ref} = 25 °C

T	K_t	α	T	K_t	α	T	K_t	α
0	0.54	1.8	60	1.76	2.2	130	3.34	2.2
10	0.72	1.9	70	1.99	2.2	140	3.56	2.2
20	0.90	2.0	80	2.22	2.2	150	3.79	2.2
25	1.0	-.—	90	2.45	2.2	160	4.03	2.3
30	1.10	2.0	100	2.68	2.2	170	4.23	2.2
40	1.31	2.0	110	2.90	2.2	180	4.42	2.2
50	1.53	2.1	120	3.12	2.2	190	4.61	2.2
						200	4.78	2.2

2. Standard temperature compensation with EXA ISC402

From the factory EXA ISC402 instruments are calibrated with a general temperature compensation function based on a sodium chloride salt solution. This is suitable for many applications and is compatible with the compensation functions of typical laboratory or portable instruments.

A temperature compensation factor is derived from the following equation:

$$\alpha = \frac{K_t - K_{ref}}{T - T_{ref}} \quad X \quad \frac{100}{K_{ref}}$$

α = Temperature compensation factor (in %/°C)
T = Measured temperature (°C)
K_t = Conductivity at T
T_{ref} = Reference temperature
K_{ref} = Conductivity at T_{ref}

3. Manual setting of temperature compensation with EXA ISC402

If the general compensation function is found to be inaccurate for the sample in question, the instrument can be set manually for a linear factor on site to match the application.

The procedure is as follows:
1. Take a representative sample of the process liquid during operation.
2. Heat or cool this sample to the reference temperature of the instrument (usually 25 °C).

NOTE: See §7-14.

3. Measure the conductivity of the solution with the ISC402 and note the reading of the display.
4. Bring the sample to the typical process temperature. Check the temperature with the display routine.
5. Adjust the reading of the display to the previously noted value at the reference temperature.
6. Check that the temperature compensation factor has been changed (from the display routine).
7. Insert the conductivity cell into the process again.

4. Calculating the approximate temperature coefficient

If the temperature coefficient of a liquid to be measured cannot be found, measure the conductivity of the liquid at two temperatures between 10 and 30°C with the temperature coefficient set to 0.00 and use the following equation to calculate an approximate temperature coefficient (α).

$$\text{Temp.coef.}(\alpha) = \frac{K_2 - K_1}{K_1(t_2 - 25) - K_2(t_1 - 25)} \times 100 (\%/°C)$$

where t_1, t_2 : liquid temperature (°C)
K_1 : conductivity at t_1 (°C)
K_2 : conductivity at t_2 (°C)

Calculation example

Calculate the approximate temperature coefficient of a liquid from the following data. Conductivity 124.5 µS/cm at a liquid temperature of 18.0 °C and a conductivity of 147.6 µS/cm at a liquid temperature of 31.0 °C. Substituting the data in the above formula gives the following result.

$$\alpha = \frac{147.6 - 124.5}{124.5 \times (31.0-25) - 147.6 \times (18.0-25)} \times 100$$

$$= \frac{23.1}{747.0 - (-1033.2)} \times 100$$

$$= 1.298$$

Set the temperature coefficient to 1.30 on the ISC402 converter (the meter can display to two places of decimals).

- Checking
  When the temperature coefficient already set is accurate, the conductivity to be displayed must be constant regardless of liquid temperature. Make sure that the temperature coefficient already set is accurate. If, when the liquid temperature is lowered, a larger conductivity value is indicated, the temperature coefficient already set is too small.
  The opposite also applies. If a smaller conductivity value is indicated, the temperature coefficient already set is too large.
  In this case, change the temperature coefficient so that the conductivity does not change.

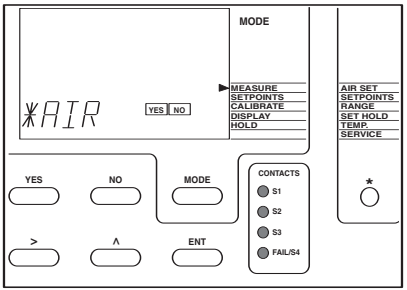
NOTE: When the ISC402 is used to determine the temperature coefficient, make sure that K1 and K2 are measured with a temperature coefficient value of 0.00

5. Other possibilities

1. Enter calculated temperature coefficient, refer to §7-13.
2. Enter matrix temperature compensation, refer to §7-24.

6-5. AIR SET

1. ACCESS AIR SET



Remove cover by releasing 4 screws

⊗ Press this key for access to commissioning mode

Select AIR SET menu

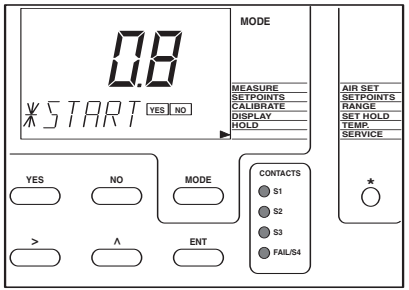
NO Press NO-key until the display indicates AIR

AIR = AIR SET menu

YES Confirm selection by pressing YES-key.

The display will indicate actual status

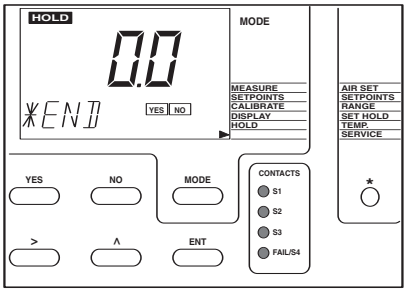
2. ACTIVATE AIR SET FUNCTION



Display shows actual status

YES Press the YES-key to start the AIR SET calibration

3. ADJUST VALUE



The display shows calibrated zero

NO Repeat calibration.
YES Confirm calibration.
MODE Return to measurement mode.

NOTE: If the sensor cannot be accurately calibrated E9 will be displayed

MODE ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

6-5. AIR SET

1. What is AIR SET procedure?

The AIR SET procedure is a routine to compensate for the small zero current due to the inductive coupling of the sensor, cabling and transmitter.

2. When is an AIR SET procedure necessary?

AIR SET is done only once during Start-Up, and when a new sensor is connected to a transmitter.

If the user wants to make full use of the systems capabilities and requires accurate measurement down to 0.5 µS/cm, this simple routine will optimize the performance.

3. How is the AIR SET procedure done?

- Prepare the whole installation as described in section 3.
- Do not install the sensor in the process, AIR SET has to be done with a dry sensor.
- Make sure that the sensor is in an EMI and RFI free environment.
- Press "*" and 4 times "NO" until "AIR" is indicated in the display.
- Press "YES" and after indication "START", press "YES" again.
- Press "YES" after the indication "END".
- End of routine.
- If required, install the sensor.

7. CONFIGURATION IN SERVICE MODE

Introduction

Usually there is no requirement to adjust the settings of the service section.
All parameters are pre-programmed to default values which lets the instrument be put into service immediately.

The advanced functions available through this section are only needed in some specific applications. This fine-tuning of the instrument gives a superior performance over conventional instruments.

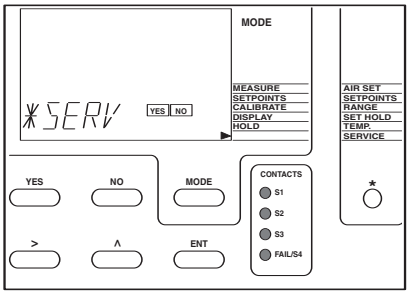
If it is necessary to adjust a function it is called-up with the appropriate code. After selecting the code the function can be activated/(not activated) or the parameters changed as required to suit the application required. After any changes are made the operator is returned to the entry point to make other adjustments or to return the instrument to the measure mode.

If errors are made during the programming process, these will be indicated, no action will be taken and the operator can start the programming again.

Code	Function	Use	Default		Section
01	Temperature sensors and units	Select sensor type and units	0.0		7-1
02	Installation factor	During start-up	1.88	cm^{-1}	7-2
03	Weight indication	Read concentration directly	0		7-3
04	Output range	Select output range	1.1		7-4
05	Output function	Conductivity (linear or table) and/or temperature	0.0		7-5
06	mA table 1	Current output	-		7-6
07	mA table 2	Current output	-		7-6
08	Contact S1	Program function	2.0		7-7
09	Contact S2	Program function	1.0		7-7
10	Contact S3	Program function	0.0		7-7
11	Contact S4	Program function	3		7-7
12	Proportional range	Set range	10	[%]	7-8
13	Proportional period	Set period	10	[sec]	7-8
14	Proportional frequency	Set frequency	70	[pulses/min]	7-8
15	Delay time and hysteresis	Delay time and hysteresis	0.2 2.0	[sec] [%]	7-9
16	Auto return	Time-out function	1		7-10
17	Burn function	Signal fail on output	0		7-11
18	Temperature adjustment	Adjust temperature offset			7-12
19	Temperature coefficient	Adjust T.C.	2.1	[%]	7-13
20	Reference temperature	Only if different from 25 °C	25/77	[°C/ °F]	7-14
21	Alarm time-out	Timer function	0		7-15
22	Set time	Set current time	-		7-16
23	Temperature hysteresis	Set hysteresis temp. alarm	1.0/2.0	[°C/ °F]	7-17
24	Enable Setpoint adjust in maintenance	Allow access to SETPOINT function	0		7-18
25	Deactivate Error E6	Disable low conductivity error	1		7-19
26	Soft fail	Programme errors to signal fail	1	[all codes]	7-20
27	Communication setup	Set-up comm link to P.C.	0.1		7-21
28	Logbook	Clear logbook			7-22
30	Select matrix	Select matrix temperature compensation	-		7-23
31-36	Program matrix	User program matrix	-		7-24
50	Test	Built in test	-		7-25
55	Defaults	Restore default values	-		7-26
66	Passcodes	Protect data	0.0.0		7-27

7-0. ACCESS TO SERVICE SETTING

1. ACCESS TO SERVICE MENU



Remove cover by releasing 4 screws

⊗	Press this key for access to commissioning mode
NO	Select calibration routine Press NO-key until display indicates SERV.

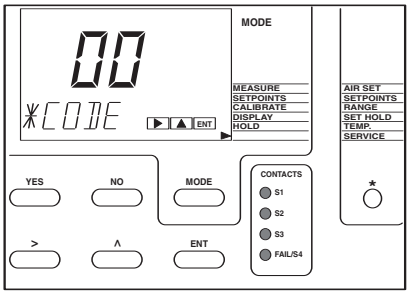
SERV = Service menu

YES	Confirm selection by pressing YES-key.

The display will indicate CODE.

NOTE: If a passcode in §7-27 has been activated, the display will indicate PASS after pressing the YES-key. Enter the correct passcode to be given access to the service mode.

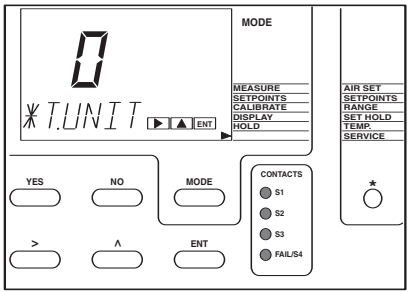
2. ENTER CODE TO SELECT THE REQUIRED SERVICE FUNCTION



Display indicates CODE
Enter access code to select function

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value

3. ADJUST SETTING



Display indicates current setting.
Adjust the setting in accordance with the instructions in the appropriate section §7-1 to §7-27.

>	Select digit to adjust
^	Adjust value
ENT	Confirm adjusted value
MODE	Return to measurement mode

MODE	ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated, the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.

7-1. Temperature sensor & units

ACCESS CODE : 01
(see §7-0 for operation)
DISPLAY : *T.CODE
Adjustment : X.X

X.X	
X.0	Temperature in °C
X.1	Temperature in °F
0.X	NTC
1.X	PT1000

Explanation:
The code for the temperature units determines the temperature indication on the display. The sensor selection chooses between the integral (NTC) sensor, and external PT 1000 Ω RTD.

Default: NTC. °C.

* put PT 1000 Ω RTD on one line

7-2. Installation factor adjustment

ACCESS CODE : 02
(see §7-0 for operation)
DISPLAY : *I.F.

Adjustment:
Adjust the ratio between the measured conductance of the sensor and the specific conductivity of the solution.

Explanation:
The Installation factor for the ISC40 is the ratio between the measured conductance of the sensor and the specific conductivity of the solution. The unit is /cm just as the cell constant of the contact electrode conductivity sensors. This factor is 1.88/cm for the ISC40 sensor if installed with minimum of 25 mm of process fluid around the doughnut.

Installed in stainless steel flow fitting (Model ISC40FF-S) the factor for ISC40 is 1.88.
Installed in a PP or PVDF flow fitting (Model ISC40FF-P or F) the factor is 1.88.
The factor is a function of the distance between sensor and the surrounding piping and is given in the figure below.

Default: 1.88/cm

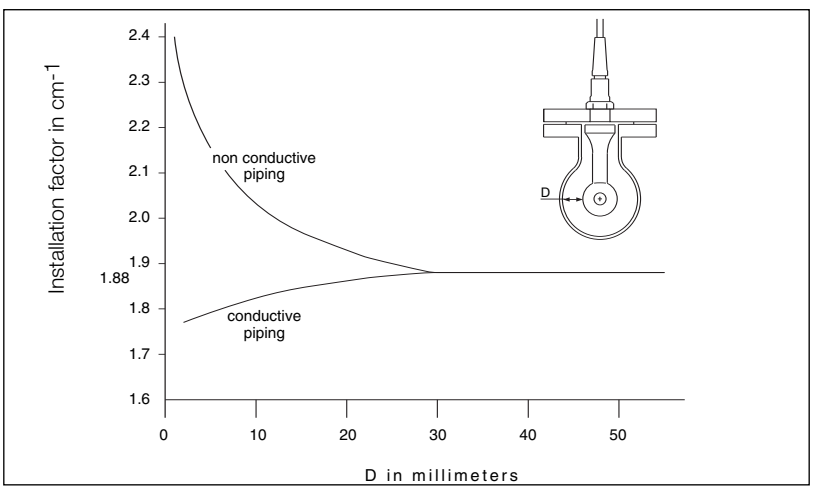


Figure 7-1.

7-3. Weight % on second display line

ACCESS CODE : 03
(see §7-0 for operation)

NOTE: This routine is only useful if the output range in code 05 is linear to weight %.

DISPLAY : *%

Adjustment : X.X

X.X		
0.X	OFF	%.1
1.X	ON	%.1
X.0	OFF	%.2
X.1	ON	%.2

Select the possibility to display % by weight on the second display line. When the % by weight indication is activated (Select 1) the display range can be adjusted:

If one or both are selected, next message will be "* %1" (or "* %2" if %1 is not selected). After pressing yes or no, the 0% and 100% of this compensation can be set.
If both are selected, next message will be '* %2' . After pressing yes or no, the 0% and 100% of the second compensation can be set.

* 0%: Adjust low span display value;
*100%: Adjust high span display value.

Explanation:
In case a conductivity measurement is used for concentration monitoring it can be convenient to link the measured conductivity value to a % by weight concentration value. A linear concentration indication in % units is programmed by entering two values.
- X in 3 digits corresponds to 0% of the output value (= 0 mA)/(= 4 mA).
- Y in 3 digits corresponds to 100% of the output value (= 20 mA).

Example:
0% output is 93.0% by weight.
100% output is 99.0% by weight.

The instrument uses interpolation between the entered values. As the relation between percent by weight concentration and conductivity is not linear in most cases, the possibility to linearize the output to concentration units can be used. Refer to §7-5 and §7-6. The instrument becomes a concentration meter by output function and (second) display (line) based on a conductivity measurement.

Default: 0.0 = Both OFF

7-4. Output range

ACCESS CODE : 04
(see §7-0 for operation)

DISPLAY : * mA

Adjustment : X.X

X.X	
0.X	0-20 mA range for mA 1.
1.X	4-20 mA range for mA 1.
X.0	0-20 mA range for mA 2.
X.1	4-20 mA range for mA 2.

Explanation:
The current output signal range is determined by the setting here.
Outputs mA 1 and mA 2 are a linear function of conductivity (if not programmed otherwise through a table, refer to §7-5 and §7-6).
Output 2 can also represent temperature, refer to §7-5.
The two outputs are limited to a 2.5% overrange (20.5 mA).
The two outputs can be programmed to give 22 mA in a FAIL condition, refer to §7-11.
The two output signals can be frozen at a fixed or last occurring value with the HOLD function (see §5-3).

Default: 1.1 = 4-20 mA for mA 1 and mA 2.

7-5. Output function

ACCESS CODE : 05
(see §7-0 for operation)

DISPLAY : OUTP. F

Adjustment : X.X

X.X	
0.X	Linear range for mA 1.
1.X	Output table for mA 1.
X.0	Linear range for mA 2.
X.1	Output table for mA 2.
X.2	Temperature output for mA 2.

Explanation:
As a default, a linear output is set and only 0% and 100% can be adjusted from the commissioning output function.
When an output table is programmed by setting a 1, the table can be programmed through code 06.
If 1 is not selected code 03 cannot be accessed. See also codes 06 an 07.
The actual process temperature can be transmitted on mA 2.

Default: 0.0 = Linear conductivity mA 1 and mA 2.

Temperature range should be set in configuration mode § 6-2 Output range adjustment.

7-6. Output table for non linear range

ACCESS CODE : 06 (mA 1) and
07 (mA 2) (see NOTE)
(see §7-0 for operation)

DISPLAY : *0% to 100%

Adjustment :
A 21 step table can be programmed from this entry **ONLY** if it was selected in code 05. It is possible to set up a linear output to concentration units.

NOTE: Access to codes 06 & 07 is only possible if "1" is programmed in code 05.

Other possibilities:
Programming "% by weight" indication on second display line, refer to §7-3.

Explanation:
An example will be used to explain the procedure.
Sulphuric acid in the range of 0-25% and a reference temperature of 25 °C (see literature for conductivity curves at 25 °C).

1. Define minimum value (0% sulphuric acid = 0 mS/cm).
2. Define maximum value (25% sulphuric acid is 791 mS/cm).
3. Divide range by 20 and calculate conductivity values (each point is 25/20 = 1.25 % by weight).
4. Fill in the table.

NOTE: Sometimes not all of the 21 values are known. If an unknown value is prompted, press the NO-key. The converter will step to NEXT value and find the unknown value by interpolation. Alternatively you can set up a bi-linear, logarithmic or hyperbolic scale: examples to program these scales are on pages 46.

OUTPUT LINEAR TO CONCENTRATION
EXAMPLE 0-25% SULFURIC ACID

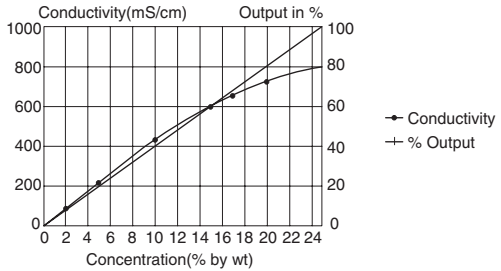


Figure 7-2.

% Output	mA	Concentration	Example	Conductivity	Example
0	4		0		0
5	4.8		1.25		60
10	5.6		2.5		113
15	6.4		3.75		180
20	7.2		5		218
25	8		6.25		290
30	8.8		7.5		335
35	9.6		8.75		383
40	10.4		10		424
45	11.2		11.25		466
50	12		12.5		515
55	12.8		13.75		555
60	13.6		15		590
65	14.4		16.25		625
70	15.2		17.5		655
75	16		18.75		685
80	16.8		20		718
85	17.6		21.25		735
90	18.4		22.5		755
95	19.2		23.75		775
100	20.0		25		791

7-7. Contacts S1 to S4

ACCESS CODE : 08, 09, 10 and 11
(see §7-0 for operation)
DISPLAY : *S1, *S2, *S3 and *S4

For *S1, *S2 and *S3

Adjustments : X.X

X.X	
0.X	Not activated
1.X	Low process alarm
2.X	High process alarm
4.X	Hold
X.0	Process alarm
X.1	Proportional duty cycle
X.2	Proportional pulse frequency control
X.3	Temperature alarm

For *S4

Adjustments : X

X	
0	Off
1	Low process alarm
2	High process alarm
3	FAIL
4	Hold

Explanation:

The settings determine the function of all four output contacts S1, S2, S3 or S4.

If the first digit is a 1 or a 2 the contact is activated and the set points can be adjusted in the SETPOINTS menu, refer to §6-3.

The second digit chooses the functioning of the contact output. The process alarm function is triggered by the changing process value. The hysteresis and delay-time are set in §7-9.

The proportional duty cycle control uses the setpoint and a proportional range (programmed in (§7-8)) to calculate the duty cycle of the contact output. The pulse period is fixed. The control range of the duty cycle is between 10 and 90%.

Outside the proportional range the duty cycle is 0% or 100%.

The proportional pulse frequency control uses the set point and a proportional range (programmed in §7-8) to calculate the number of pulses. The maximum pulse frequency is fixed. The pulse duration time is fixed at 0.3 seconds. This is also illustrated in Figs. 10-1, 10-2 and 10-3.

The defaults are:

S1:	2.0	1.000 mS/cm High SC alarm
S2:	1.0	10.0 µS/cm Low SC alarm
S3:	0.0	10.00 mS/cm Off
S4:	3	10 mS/cm FAIL function

7-8. Settings for proportional control

ACCESS CODE : 12, 13 and 14
(see §7-0 for operation)
DISPLAY : *RANGE, *PER.,
*FREQ.

Adjustment:
The proportional range (*RANGE) is set in % of the programmed output range.
The proportional pulse period (*PER) is set in seconds.
The proportional pulse frequency (*FREQ) is set in pulses per minute.

Explanation:
It is only useful to set these values when one or more contacts will be used for proportional control. The selection of the proportional control is described in §7-7.
Whether you have selected proportional duty cycle control or proportional pulse frequency control, you have to program the proportional range with access code 12 for both. This determines the range in which the control takes place and changes the control output between 0% and 100%.

The proportional pulse period should be set when duty cycle control is selected. The pulse period can be set between 5 to 100 seconds. The duty cycle is controlled between 10% and 90% by the deviation from the setpoint with the proportional range, refer to Fig 10-2.
Below setpoint relay is 0% on, and above proportional range 100% on.
The proportional pulse frequency should be set when the pulse frequency control is programmed. The maximum number of pulses can be set between 50 to 120 pulses per minute. The number of pulses is controlled between zero (0) and the programmed maximum by the deviation from the setpoint within the proportional range, refer to Fig. 10-1.

NOTE: Proportional control only for contacts output allocated to conductivity.

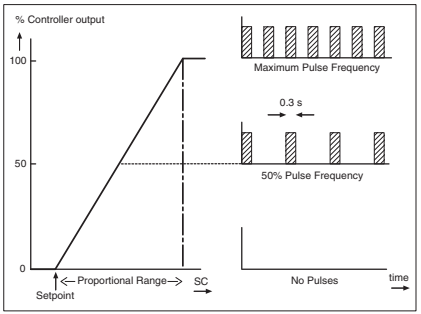


Figure 7-3. Pulse frequency control

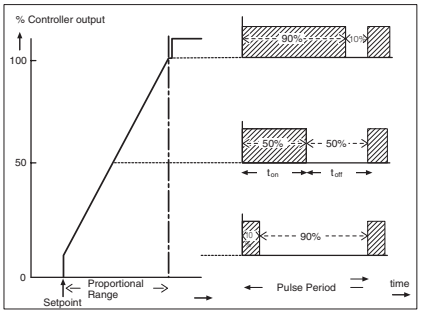


Figure 7-4. Duty cycle control

Defaults:
Proportional range 10%
Limits 0-100%
Proportional period 10 seconds
Limits 5-100 seconds
Proportional frequency 70 per minute
Limits 50-120 per minute

7-9. Setting the process alarm function

ACCESS CODE : 15
(see §7-0 for operation)
DISPLAY : *D.TIME and *HYST

Adjustment:
Setting the delay time (in seconds) and hysteresis (in percent of setpoint).

Explanation:
The delay time is counted from the moment that the process value has passed the setpoint of the alarm function, refer to Fig. 10-3. When dealing with a high [low] alarm the relay will switch back after the process value has passed both setpoint minus [plus] the hysteresis (dead-band) in percent of the setpoint value.
The programmed values are shared by all four contacts S1, S2, S3 and S4.

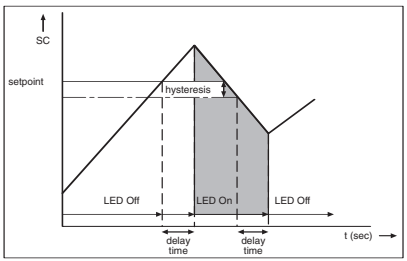


Figure 7-5. Delay time and Hysteresis

NOTE: For hysteresis on temperature contact function, refer to service code 23 (§7-17).

Defaults:
Delay time: 0.2 sec
Limits: 0.0-200 sec
Hysteresis: 2.0%
Limits: 0.1-100%

7-10. Auto return function

ACCESS CODE : 16
(see §7-0 for operation)
DISPLAY : *RET

Adjustment: (X)

X	
0	No automatic return to measurement
1	Automatic return to measurement after 10 minutes

Explanation:
As a safeguard against long maintenance jobs or inadvertently pushing a button it is possible to let the system return to its normal function of measurement when no keys are pushed for 10 minutes.

If the HOLD function is activated the automatic return function will take the instrument to hold after 10 minutes and switch to measurement after another 10 minutes if no keys are pressed.

Default: 1 = Auto return activated

7-11. Signalling of fail condition

ACCESS CODE : 17
(see §7-0 for operation)
DISPLAY : *BURN

Adjustment : (X)

X	
0	No special output on FAIL.
1	Special output signals on FAIL activated.

Explanation:
In addition to the indication on the display and the switching of the FAIL contact , a special output signal can be activated to indicate a fault in the measuring loop. The signal is on both outputs mA 1 and mA 2 and has a value of 22 mA which is outside the normal analog range. It is necessary to make sure that the equipment (e.g. strip-recorder, control system etc.) can react to this signal level. If an alarm can be set to react to this signal level an additional safety measure against irrelevant measurements can be built into the system.
The system uses the same convention that is used in the detection of thermocouple "burn-out" detection by going up-scale. The upper limit of the normal signal is 20.5 mA.

Default:
0 = OFF

7-12. Temperature adjustment

ACCESS CODE : 18
(see §7-0 for operation)

DISPLAY : *T.ADJ

Adjustment : Setting the measured temperature to a calibrated value, using the >, ^ and Ent keys.

Explanation:
The temperature measurement uses a resistance measurement principle. In this kind of measurement the length of the connecting cable can influence the accuracy of the temperature indication. To compensate for the extra resistance of the cable an adjustment of up to ± 2.5 °C can be made.
Connect the correct temperature sensor to the EXA instrument and insert it into a temperature bath which has stabilized at a known suitable value. Check the value indicated at instrument and adjust the instrument to the actual value of the temperature bath.

The transmitter has now been calibrated for the temperature sensor cable length.

7-13. Temperature coefficient

ACCESS CODE : 19
(see §7-0 for operation)

NOTE: Access to this routine is only possible if "TEMP 1" or "TEMP 2" routine is set to "T.C." in section 6-4.

DISPLAY: *T.C.1 and/or T.C.2

Adjustment:
Adjust the value of the compensation factor (α).

Explanation:
In addition to the procedure described in §6-4 it is possible to adjust the compensation factor of the sample liquid if the compensation factor is known from laboratory experiments or has been previously determined. The value can be introduced here.
Adjust the value between 0% and +3.5% per °C. In combination with the reference temperature setting at §7-14 a linear compensation function is obtained, suitable for many kinds of chemical solutions.

Default: skipped, compensation for NaCl is standard.

$$\alpha = \frac{K_t - K_{ref}}{T - T_{ref}} \times \frac{100}{K_{ref}}$$

Calculating the approximate temperature coefficient

If the temperature coefficient of a liquid to be measured cannot be found, measure the conductivity of the liquid at two temperatures between 10 and 30 °C with the temperature coefficient set to 0.00 and use the following equation to calculate an approximate temperature coefficient (α).

$$\text{Temp.coef.}(\alpha) = \frac{K_2 - K_1}{K_1(t_2 - 25) - K_2(t_1 - 25)} \text{X100(\%/°C)}$$

where t_1, t_2 : liquid temperature (°C)
K_1 : conductivity at t_1 (°C)
K_2 : conductivity at t_2 (°C)

Calculation example

Calculate the approximate temperature coefficient of a liquid from the following data. Conductivity 124.5 µS/cm at a liquid temperature of 18.0 °C and a conductivity of 147.6 µS/cm at a liquid temperature of 31.0 °C. Substituting the data in the above formula gives the following result.

$$\alpha = \frac{147.6 - 124.5}{124.5\text{X}(31.0\text{-}25) - 147.6\text{x}(18.0\text{-}25)} \text{X100}$$

$$= \frac{23.1}{747.0 - (-1033.2)} \text{X100}$$

$$= 1.298$$

Set the temperature coefficient to 1.30 on the SC meter (the meter can display to two places of decimals).

- Checking
  When the temperature coefficient already set is accurate, the conductivity to be displayed must be constant regardless of liquid temperature. Make sure that the temperature coefficient already set is accurate.

  If, when the liquid temperature is lowered, a larger conductivity value is indicated, the temperature coefficient already set is too small.

  The opposite also applies. If a smaller conductivity value is indicated, the temperature coefficient already set is too large.

  In this case, change the temperature coefficient so that the conductivity does not change.

NOTE: When the ISC402G is used to determine the temperature coefficient, make sure that K1 and K2 are measured with a temperature coefficient value of 0.0.

7-14. Reference temperature

ACCESS CODE : 20
(see §7-0 for operation)
DISPLAY : *T.R.°C or *°F

Adjustment : Adjust the value for the reference temperature used in the calculations. Normally this value will be 25 °C.

Explanation:
All measured values are compensated for temperature to refer to comparable values at 25 °C. This temperature is easily produced at laboratory conditions and most literature data use this temperature.
In exceptional cases it is possible to use a different reference temperature in combination with a programmed temperature coefficient (e.g.Sulphuric acid measurement).

Default: 25 °C/77 °F
Limits: 0-100 °C / 30-225 °F

7-15. Timer on contact function

ACCESS CODE : 21
(see §7-0 for operation)
DISPLAY : *EXPIR/*tE.min

Adjustment : (X)

X	
0	No timer
1	Timer function activated

When 1 is selected, use the **>** and **^** keys to program the contact action expiry time in minutes.

Explanation:
When the contacts are used for a control function contact action should have a result.

If the result (measurement within a safe band) does not take place within a set expiry time, error E22 is triggered (see also (§8-4)).
The error code E22 can be cancelled by pushing the [YES] or [NO] keys. The timer is reset.

Default: 0 = No timer

7-16. Setting the clock

ACCESS CODE : 22
(see §7-0 for operation)
DISPLAY : *HOUR

Adjustment:
Set the internal clock to the current time. Use the **>**, **^** and ENT keys to program the current time. The sequence is Hours, Minutes, Seconds, Year, Month, Day. Press enter after each operation.

Explanation:
This function is used as an event time output for the logbook.

NOTE:
1. *A battery is incorporated in the instrument to support the clock function if power is removed from the instrument.*
2. *The battery should be changed every 5 years or if the time function does not keep correct time. Contact your local Yokogawa Service Centre for details.*
3. *The battery is a Lithium type, it should be disposed of in accordance with the local health and safety regulations.*

7-17. Settings for the temperature hysteresis

ACCESS CODE : 23
(see §7-0 for operation)
DISPLAY : *T.HYST

Adjustment:
Settings the hysteresis for setpoint of contact allocated to process temperature.

Explanation:
When dealing with a high [low] alarm the relay will switch back after the process value has passed the setpoint minus [plus] hysteresis. The hysteresis (dead-band) can be adjusted in absolute units for temperature measurement.
A specific setting of the hysteresis is valid for all contacts allocated to that specific parameter.

Default	Limits
1.0 °C	0.1-5.0 °C
2.0 °F	0.2-10.0 °F

NOTE: The default is dependent on the setting in Service Code 01.

7-18. Enable Setpoint adjustment in maintenance

ACCESS CODE : 24
(see §7-0 for operation)
DISPLAY : *MODE

Adjustment: (X)

X	
0	Setpoints programmable at the commissioning level only (*-key)
1	Setpoints also programmable at the maintenance level (MODE key)

Explanation:
Normally setpoints of the contact outputs can only be adjusted on commissioning level to get access, the cover has to be removed. For convenience the setpoints adjustment routine can be made available on maintenance level; access through cover window.

Default: 0 = Setpoint setting not available on maintenance level.

7-19. Deactivate Error E6

ACCESS CODE : 25
(see §7-0 for operation)
DISPLAY : EN E6

Adjustment: (X)

0	Error E6 disabled
1	Error E6 enabled

Explanation:
Error E6 signals loss of sample (i.e. cell not wetted). As this is a normal state in some batch processes, E6 may be used to signal a fault condition in the absence of sample, or not, to suit the process.

7-20. Fail status signalling

ACCESS CODE : 26
(see §7-0 for operation)
DISPLAY : *Err.X
*SOFT

Adjustment: (X) (for each error code number displayed).

X	
0	Error triggers flashing FAIL flag and LED and pulsating FAIL contact.
1	Error triggers continuous FAIL flag and LED, continuous FAIL contact and, if activated, a 22 mA output signal. All other contacts will be deactivated.

Explanation:
As described in chapter 8, the error code marked with an asterisk (*) in §8-4 normally will trigger a number of actions:
- The FAIL contact closes
- The FAIL flag and LED are lit
- All other contacts (S1, S2, S3) are deactivated and (when activated in service code 17) the output signals go up to 22 mA.

In this service routine for each (asterisk marked) error code the actions can be reduced to a flashing FAIL flag and LED and a pulsating FAIL contact (or, if *SOFT=1, a flashing FAIL. flag only).

Default: Error codes 05, 06, 07, 08, 22 = 1 (fully signalling).

7-21. Communications setup

ACCESS CODE : 27
(see §7-0 for operation)
DISPLAY : *COMM

Adjustment:

1. To set communications on or off (X.X)

X.X	
0.X	Off
1.X	On
X.0	Write enabled
X.1	Write protected

2. If set to on, to set baud rate and parity (X.X)

X.X	
0.X	1200
1.X	2400
2.X	4800
3.X	9600
X.0	off
X.1	odd
X.2	even

3. If set to on, to set network address (XX)

   Enter value between 0 and 15.

Explanation:
This function is used to communicate between a computer and the instrument.

NOTE: Details of this function, its use and connections are included in the information package supplied with the interface and the communications software available as an optional extra. It can be ordered under part number PC402.

7-22. Logbook clear
ACCESS CODE : 28

DISPLAY : LOG.CRL

Explanation:
This function is only available in combination with the communications output package. This function is used to set the level of event logging, approximately 100 events can be stored in memory. When the memory is full, new events are logged by writing over the oldest entry.

7-23. Selection of standard electrolytes
ACCESS CODE : 30 (see NOTE)
(see §6-4 for operation)
DISPLAY : *MATRIX

Adjustment : Refer to table below.

Explanation:
For convenience, Yokogawa has already programmed some common electrolytes, where sophisticated temperature compensation is required for accurate process control.

Code	Electrolyte	Temperature Range	Concentration Range
1	H_2SO_4	0-100 °C	0-5%
2	Sulphuric acid		0-25%
3	HCl	0-60 °C	0-5%
4	Hydrochloric acid		0-20%
5	HNO_3	0-80 °C	0-5%
6	Nitric acid		0-25%
7	NaOH	0-100 °C	0-5%
8	Sodium Hydroxide		0-15%
9	ACCESS CODE 31.....36		

NOTE: Select the range as close as possible to the actual temperature/concentration range. The ISC402 will compensate by interpolation and extrapolation. Consequently, there is no need for a 100% coverage. The actual measuring range is defined in §6-2 or §7-5 & 7-6.

7-24. Matrix Temperature compensation

ACCESS CODE : 31, 32, 33, 34, 35 and 36 (see NOTE)
(see §7-0 for operation)

NOTE: These codes can only be accessed if temperature compensation in §6-4 is set to "MATRIX" and if code 30 is set to 9.

In these service codes the ISC402 transmitter can be tailored for one particular application.
For the temperature range that is programmed in access code 31, the specific conductivities are given for 5 different concentrations of the process liquid, each in a specific access code (32 to 36 inclusive).

ACCESS CODE : 31
DISPLAY : T1 °C or T1 °F

Adjustment:
Adjust this value to the lower limit of the required temperature range and press "ENT".

DISPLAY : T5 °C or T5 °F
Minimum span should be 50 °C or 90 °F

Adjustment:
Adjust this value to the upper limit of the required temperature range and press "ENT".

ACCESS CODE : 32
DISPLAY : L1 x T1
Adjustment:
Adjust this value to the conductivity of the first solution at temperature T1. Press "ENT".

DISPLAY : L1 x T2

Adjustment:
Adjust this value to the conductivity value of the first reference solution at the second reference temperature T2.

Continue this process until "SERV" is displayed.

ACCESS CODE : 33
DISPLAY : L2xT1

Adjustment:
Repeat the adjustment as described under code 31, but now with the second solution.

ACCESS CODES : 34, 35 and 36
These rows have to be filled in the same way as described under code 32.

1. *In defining the temperature compensation range, it is important to choose T1 and T5 in such a way that the 5 reference temperatures are user friendly:*
   Example: T1 = 0 and T5 = 80 °C gives reference temperatures of 0, 20, 40, 60 and 80 °C. The minimum span for the range is 50 °C.
2. *Use the table in the manual to record your programmed values. It will make programming easier for duplicate systems or in case of data loss.*

NOTES:
1. *E17 occurs when a temperature range of less than 50 °C/ 90 °F is entered, or if the output span is <90% of the maximum range.*
2. *Each matrix column has to increase in conductivity value (for example L1xTx < L2xTx < L3xTx < L4xTx < L5xTx).*
3. *E4 occurs when two standard solutions have identical conductivity values at the same temperature within the temperature range.*

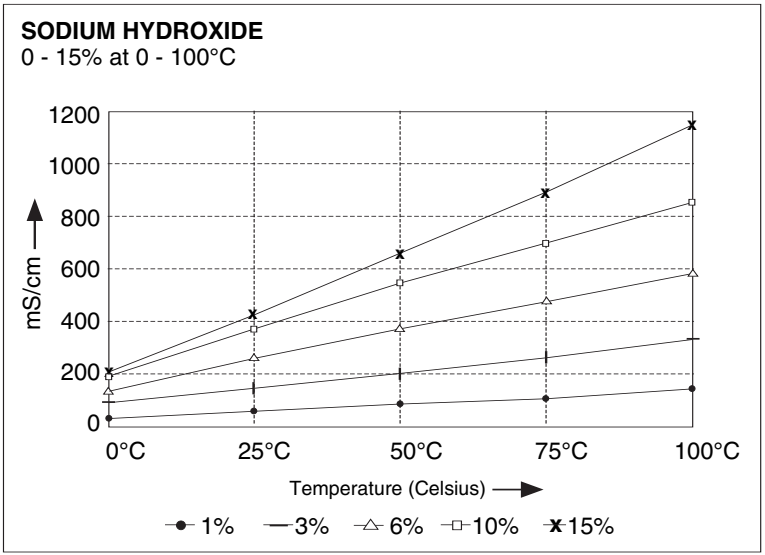


Figure 7-6.

Matrix			example	actual	example	actual	example	actual	example	actual	example	actual
CODE 31	TEMPERATURE	T1 .. T5	0		25		50		75		100	
CODE 32	SOLUTION 1	L1	31		53		76		98		119	
CODE 33	SOLUTION 2	L2	86		145		207		264		318	
CODE 34	SOLUTION 3	L3	146		256		368		473		575	
CODE 35	SOLUTION 4	L4	195		359		528		692		847	
CODE 36	SOLUTION 5	L5	215		412		647		897		1134	

7-25. Built-in Test function

ACCESS CODE : 50
(see §7-0 for operation)
DISPLAY : *TEST,

Explanation:
This function tests the transmitter. Do the following procedure :

Action	Display
Enter service code 50 and press ENT.	*TEST and YES/NO.
Press YES.	*CAL and YES/NO.
Press YES.	Calibrate installation factor = 1.00 (for test mode only). Adjust displayed value to agree with calculation.
Press ENT.	Conductivity value and temperature displayed.
Press ENT.	0.0 (upper line), mA 1 + mA 2 (lower line).
Press ENT and repeat until display shows 22 mA.	After each press of ENT the value of the display will increase as follows : 0, 4, 8, 12, 16, 20 and 22 mA. For both mA1 and mA2.
When the display indicates 22 mA press ENT.	*S1 shows.
Press the ∧ key.	Each time the ∧ key is pressed the contact will be toggled and the LED will switch state.
Use the > key to select * S2, S3 and S4 and repeat the test.	
After testing S4, Press ENT. This tests the communications function.	*COMM
Press ENT to exit TEST mode.	*SERV

7-26. Restore default settings

ACCESS CODE : 55
(see §7-0 for operation)
DISPLAY : *ERASE

Adjustment: YES = Erase all programmed values and replace them by defaults.
NO = Keep all programmed values as before.

Explanation:
This entry gives the facility to let erase all previously programmed values and replace them with the factory set default values. If YES is pressed the data in the non-volatile memory will be replaced by the default values.

CAUTION:
DO NOT USE THIS CODE WITHOUT THE PROPER AUTHORITY AS ALL SETTINGS, PROGRAMMED FUNCTIONS AND TABLES WILL BE LOST. IT IS NOT POSSIBLE TO RETRIEVE THE DATA AFTER YES HAS BEEN PRESSED.

The purpose of this function is to reset the instrument to be moved to a new location or be used for a different process with the factory defaults being used as a starting point.

CAUTION
Do not enter service codes that are not listed in this manual.
Entering invalid service codes can result in a loss of factory set data.

7-27. Data protection by three digit code

ACCESS CODE : 66
(see §7-0 for operation)
DISPLAY : *PASS

Adjustment: (X.X.X)

X.X.X	
0.-.-	Protection on Maintenance level not activated
-.0.-	Protection on Commissioning level not activated
-.-.0	Protection on Service level not activated
#.-.-	Protection on Maintenance level activated
-.#.-	Protection on Commissioning level activated
-.-.#	Protection on Service level activated

NOTE: # can be a digit from 1 to 9 and it will give a protection level according to the list below:

0 = No passcode
1 = Passcode is 111
2 = Passcode is 333
3 = Passcode is 777
4 = Passcode is 888
5 = Passcode is 123
6 = Passcode is 957
7 = Passcode is 331
8 = Passcode is 546
9 = Passcode is 847

Explanation:
In some cases a protection of operation levels is wanted. In this way unauthorized access to any of the 3 levels can be blocked by a simple passcode. When a passcode is selected for an operation level, access to that level can only be obtained after entering the passcode. The display will show a message *PASS* to indicate the entry of the passcode.

NOTES:
1. *At the Maintenance and Commissioning level the passcode entry is requested when entering from the measure mode.*
2. *At the Service level the passcode entry is requested after pushing the YES-key.*
3. *When the Service level protection is activated, the passcode cannot be changed by unauthorized persons.*
4. *For maximum protection from unauthorized changes, see also § 7-21 (communications write protect).*

Default: 0.0.0
No Passcode protection.

8. TROUBLE SHOOTING

8-1. Introduction

The EXA ISC402G microprocessor based conductivity analyzer continuously monitors the condition of all key components of the measuring system to ensure that measurement is reliable. If a fault is detected it is immediately signalled. Errors are shown on the display with a code. The following table shows the errors which can be detected and gives information to help locate the fault or identify the error. Faults detected while the instrument is on line can also be signalled by a (temporary) high output (22 mA) signal, refer to §7-20.

8-2. Self diagnostics of the electronics

The microprocessor operation is checked by a watchdog which initiates an electronic reset if the normal functions suffer severe interference. During reset the instrument checks the program and all stored data. If a fault is then detected an alarm is given.

8-3. Checking during operation

Whenever the instrument is being programmed or calibrated, data is checked and an error is shown when appropriate. Should this occur the new data is rejected and the instrument continues to work with the previous settings.

8-4. Error messages and explanation

Code	Error description	Possible cause	Remedy
E2	Temperature coefficient incorrect.	Calculated TC not between 0.00 and 3.50%/ºC. TC too high for measured temperature.	See §7-13
E3	Installation Factor out of range.	Wrong unit (mS or µS) Defective sensor Standard error	See §7-2 Replace sensor Check standard
E4	Impossible program for Temperature Compensation	Incorrect in 5 x 5 matrix (See codes 32-36)	See §7-24
E5*	Conductivity too high	Incorrect wiring Defective sensor	Check wiring Replace sensor
E6*	Conductivity too low	Sensor not submersed Sensor plugged Incorrect wiring Defective sensor	Check installation Clean sensor Check wiring Replace sensor
E7*	Temperature too high	Incorrect wiring Shorted Temperature Sensor	Check wiring Replace sensor
E8*	Temperature too low	Incorrect wiring Open Temperature Sensor	Check wiring Replace sensor
E9	Impossible AIR SET	Too high ZERO	Replace sensor
E10	EEPROM write failure	Software problem	Unplug the unit Try again Call Yokogawa
E15	Impossible adjustment temperature	Corroded contacts-wrong sensor programmed	Clean and reterminate-Reprogram see §7-13
E17	Span error.	SC Zero Suppression > 90% Temp. span <50 °C / <90 °F	see §7-6
E18	Impossible program for output table	Incorrect data in code	See §7-6
E19	Programmed values not accepted	Values exceed pre-set limits	Try again, read instructions

Continuation from page 61.

Code	Error description	Possible cause	Remedy
E20	Data integrity not good.	Unauthorized programming Software problem	The unit has to be re-initialized Call Yokogawa
E21	Corrupted EPROM	Software failure	Call Yokogawa
E22*	Expired contact action interval	Ineffective process control	Check control loop

* These errors will trigger the FAIL if set to on (default is on).

NOTE: If abnormal values are displayed, usually in combination with E5, E6, E7 or E8 messages, then check with your local Yokogawa Service Centre.

NOTE: If abnormal readings are displayed the process can be simulated by a loop through the dry doughnut to a resistance box (Yokogawa QT40 sensor simulator). The reading should agree with IF. 1000/R in µS/cm in which R = Resistance in kOhm and IF = programmed Installation Factor, typically 1.88.

SPARE PARTS

Description	Part Number	Pos. Number
Cover assembly, including 4 pcs. M4 x 20 screws	K1541JG	1
Digital and display board assembly *	K1543DA	2
EEPROM with software (inc. label)	K1543BG	3
Protective cover for power terminals (inc. screw)	K1543JH	4
Input and output board assembly: 230 V AC 115 V AC 100 V AC 24 V DC	 K1543TF K1543TG K1543TN K1543TM	5
Fuse holder	K1543AA	6
Housing	K1541JJ	7
Fuse 230 V AC 115 V AC 100 V AC 24 V DC	K1543AK K1543AL K1543AL K1543AM	8
One gland	K1500AU	9
Flat cable	K1543AB	10
Screw and washer	K1543AC	11
Hingepin	K1543KS	12
Lithium cell	K1543AJ	Not indicated

* See figure 8-1.

EXPLODED VIEW

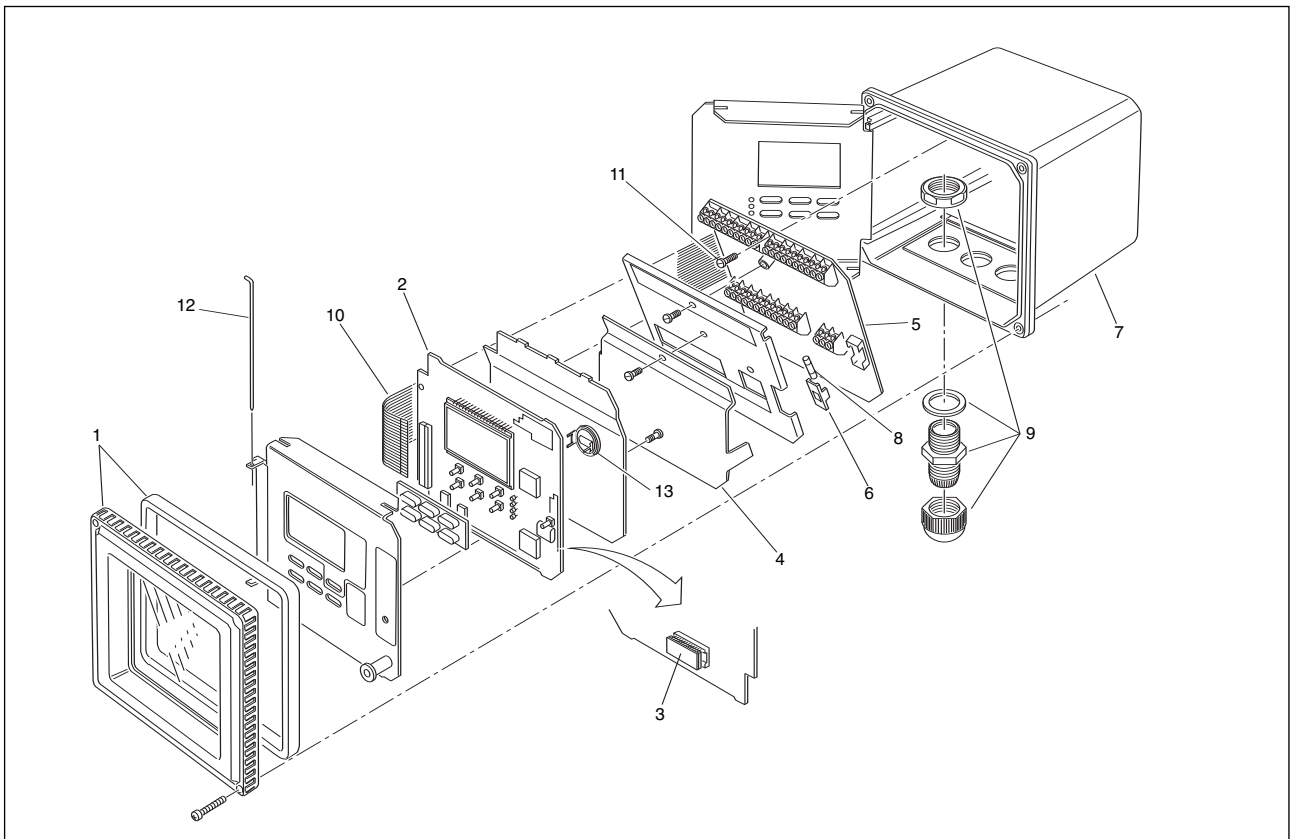


Figure 8-1. Exploded view

ERROR MESSAGES

CODE	DESCRIPTION
E2	TEMPERATURE COEFFICIENT INCORRECT
E3	INSTALLATION FACTOR OUT OF RANGE
E4	IMPOSSIBLE PROGRAM FOR TEMPERATURE COMPENSATION
E5	CONDUCTIVITY TOO HIGH
E6	CONDUCTIVITY TOO LOW
E7	TEMPERATURE TOO HIGH
E8	TEMPERATURE TOO LOW
E9	NO AIR SET POSSIBLE
E10	WRITING TO EEPROM FAILED
E15	TEMPERATURE CORR. OUT OF LIMITS
E17	SPAN ERROR
E18	TABLE VALUES MAKE NO SENSE
E19	PROGRAMMED VALUES NOT ACCEPTABLE
E20	ALL PROGRAMMED VALUES ARE LOST
E21	CORRUPTED EEPROM
E22	EXPIRED CONTACT ACTION INTERVAL

CODED SERVICE SETTINGS (DEFAULTS)

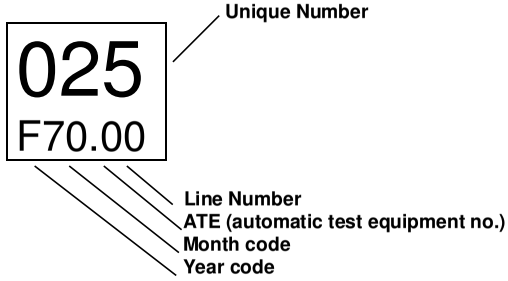
CODE	DISPLAY	FUNCTION & USE	DEFAULT	SECTION	SETTING #1	SETTING #2	SETTING #3
01	T.CODE	Select temperature sensor and units	NTC °C	7-1			
02	I.F.	Set installation factor (calibrate)	1.88 cm-1	7-2			
03	%	Set for display in Wt % units	0.0	7-3			
04	mA	Set 0-20 or 4-20 for mA 1 & mA 2	1.1	7-4			
05	TABLE	Output selection - linear SC / table - % concentration/temperature	0.0	7-5			
06	0% / 100%	Set mA output linearization mA 1		7-6			
07	0% / 100%	Set mA output linearization mA 2		7-6			
08	S1	Set relay alarm/control operation	2.0	7-7			
09	S2	Set relay alarm/control operation	1.0	7-7			
10	S3	Set relay alarm/control operation	0.0	7-7			
11	S4	Set relay FAIL/alarm/control operation	3	7-7			
12	RANGE	Set proportional range for relay control	10%	7-8			
13	PER	Set proportional control period	10 Sec	7-8			
14	FREQ	Set proportional control frequency	70 pulses/min	7-8			
15	D.TIME	Set relay delay time	0.2 Sec	7-9			
	HYST	Set relay hysteresis	2.0%				
16	RET	Select auto return on/off	1	7-10			
17	BURN	Select for 22mA on FAIL alarm	0	7-11			
18	T. ADJ	Calibrate temperature sensor		7-12			
19	T.C. 1 / T.C. 2	Set TC 1 and/or TC 2	2.1%	7-13			
20	T.R. °C / °F	Set reference temperature if different from 25°C	25°C/77°F	7-14			
21	EXPIR	Set alarm control action time out, and period	0	7-15			
22	HOUR/MINUTE/ SECOND/YEAR/ MONTH/DAY	Set date and time		7-16			
23	T.HYST	Set hysteresis for the temperature alarm.	1.0 °C/2.0°F	7-17			
24	MODE	Enable setpoint adjustment in maintenance mode	0	7-18			
25	EN. E6	Enable E6 error signal for empty cell.	1	7-19			
26	EN. E(5/6/7/8/22) *SOFT	Set errors that will trigger FAIL contact Disable FAIL Contact for soft fail	1 (all codes) 0	7-20			
27	COMM	Set up RS485 link to PC	0.1	7-21			
28	LOG.CLR	Clear logbook		7-22			
30	MATRIX	Select which matrix temperature compensation		7-23			
31	T1....T5 °C / °F	Set matrix temperature range		7-24			
32	L1XT1.....L1XT5	Set matrix conductivity values (1)		7-24			
33	L2XT1.....L2XT5	Set matrix conductivity values (2)		7-24			
34	L3XT1.....L3XT5	Set matrix conductivity values (3)		7-24			
35	L4XT1.....L4XT5	Set matrix conductivity values (4)		7-24			
36	L5XT1.....L5XT5	Set matrix conductivity values (5)		7-24			
50	TEST	Built -in test function		7-25			
55	ERASE	Restore default settings		7-26			
66	PASS	Set password protection codes.	0.0.0	7-27			

Quality Inspection Standard

EXA Series
Model IC402
Converter for Inductive Conductivity

1. Introduction

This inspection procedure applies to the model IC402 microprocessor based converter. There is a serial number, unique to the instrument which is stored in non-volatile memory. Each time the converter is powered up, the serial number is shown in the display. An example is shown below:



2. General

Final testing begins with a visual inspection of the unit to ensure that all the relevant parts are present and correctly fitted.

3. Insulation Test

During the production testing procedures, the insulation is tested between terminal 3, the supply earth, and power terminals 1 and 2. The test used applies the following criteria:
AC instruments - 2.1 kV, <1 mA, for >1 min.
DC instruments - 0.7 kV, <1 mA, for >1 min.
The outputs are also tested for isolation from earth >10 MΩ.

4. Accuracy Testing

First check that output ranges are set to SC 0-1000 mS. Refer to page 15 Section 4.2 of the Instruction Manual. The automated checks in service code 50 are used in this procedure, and an IC40 sensor is connected and calibrated in conjunction with the converter. The test equipment needed is :

1. Resistance decade boxes with ranges of 10 Ω - 100 kΩ and 0.1 Ω - 10 kΩ with an accuracy of 0.1%.
2. Two 600 Ω resistors.
3. An inductive conductivity sensor (IC40) complete with 5 metres of cable.
4. An insulated wire with a length of approx 1 metre and a minimum cross-section of 0.75 mm^2
5. A power supply to suit the converter (115 /230 VAC or 24 VDC)
6. A mA meter with a range of 25 mA and an accuracy of 0.1% and a resolution of 1 µA.

Connect the IC402 as shown in Fig. 1. The lower range decade box (bank 1) to terminals 11 & 12 to simulate the temperature input. Set decade box 1 to simulate 25 °C (30 kΩ for NTC, 1097.3 Ω for Pt1000).

The sensor is connected to terminals 13 through 17, and a single strand of wire passed through the hole in the sensor, and the ends connected to the higher range decade box (bank 2). The output terminals are connected through the 600 Ω load resistor to the mA meter.

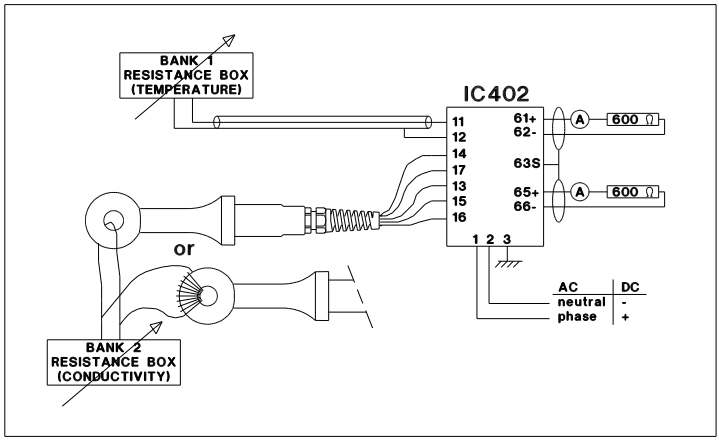


Figure 1

4.1 Zero Calibration ("Air Set")

It is now necessary to perform an air set procedure, which is in effect a zero calibration and matches the sensor to the converter.

Press the button marked *	(*AIR) appears in the lower display
Press YES	(*START) appears in the lower display
Press YES	(*WAIT) appears in the lower display, then (* END) appears
Press YES	(* AIR)

4.2 Span Calibration

It is now necessary to procede to 'code 50' in the service menu in order to check the calibration.

Press NO repeatedly	(*AIR changes to *SETP to *RANGE to *HOLD to *TEMP1 to TEMP2 to *SERV)

When *SERV is displayed, check that decade bank 1 is set for 25°C (30 KΩ for NTC or 1097.3 Ω for Pt1000) and bank 2 for 1000 Ω.

Press YES.	(*CODE) and 00 is dislayed
Select code 50 and press ENTER	(*TEST) appears
Press YES	(*CAL) appears
Press YES	and adjust the reading to 1.000 mS/cm

This completes the system calibration.

4.3 Accuracy Test (Conductivity Display)

First set decade bank 2 to the values listed below to simulate the conductivity input and check the readings on the display.

Input	Display	Tolerance	Actual Display *
100 Ω	10.00 mS/cm	± 0.05 mS/cm	*10.01* mS/cm
1 kΩ	1.000 mS/cm	± 0.006 mS/cm	*1.002* mS/cm
10 kΩ	100.0 µS/cm	± 1.0 µS/cm	*100.1* µS/cm
100 kΩ	10.0 µS/cm	± 0.6 µS/cm	*10.0* µS/cm
(Open) ∞ Ω	0.0 µS/cm	+ 0.5 µS/cm	*0.0* µS/cm

The tolerance is calculated from the accuracy specification: ± 0.5% ± 0.5 µS/cm.
Next vary the settings on decade bank 1 as listed below and check the readings on the display.

4.3.1 Accuracy Test (Temperature Display with integral NTC)

This is the default condition and most commonly used mode, for normal applications where the built in temperature sensor is used, calibration is checked as follows.

Resistance	Temperature	Tolerance	Actual Display *
158 kΩ	-10 °C	± 0.2 °C	*-10.1* °C
30 kΩ	25 °C	± 0.2 °C	*24.9* °C
2069 Ω	100 °C	± 0.2 °C	*99.8* °C

4.3.2 Accuracy Test (Temperature Display with external Pt1000 RTD)

This condition is an alternative where it is desirable to use a separate temperature sensor (for faster response for example). In order to test this alternative, the Pt1000Ω option needs to be set (1.0 in Service code 01).

Resistance	Temperature	Tolerance	Actual Display *
960.7 Ω	-10 °C	± 0.2 °C	*-10.0* °C
1097.3 Ω	25 °C	± 0.2 °C	*25.1* °C
1385 Ω	100 °C	± 0.2 °C	*100.0* °C

The tolerances specified relate to the performance of the IC402 with a calibrated sensor and purpose built test equipment. In the field, the accuracy and linearity of the sensor and test equipment affects the error in the reading. As much as an additional 1% of reading may be seen in the display.

* Values in *italics* are shown for example only.

4.3.3 Overall Accuracy Test

Change the connection to decade bank 2, so that the wire is looped around the sensor, passing 10 times through the hole. Still with the remaining equipment setup as before, measure the current outputs with the following settings and confirm agreement with the table below.

Input	Display	Tolerance	Actual Reading *	Nominal mA 0-20 or 4-20		Tolerance mA	Actual mA1 *	Actual mA2 *
(Open) ∞ Ω	0.0 µS/cm	+ 0.5 µS/cm	*0.0* µS/cm	0.00	4.00	± 0.03	*4.00*	*4.00*
500 Ω	200 mS/cm	± 1 mS/cm	*201* mS/cm	4.00	7.20	± 0.05	*7.21*	*7.19*
200 Ω	500 mS/cm	± 3 mS/cm	*501* mS/cm	10.00	12.00	± 0.08	*12.01*	*12.00*
125 Ω	800 mS/cm	± 4 mS/cm	*799* mS/cm	16.00	16.80	± 0.11	*16.79*	*16.79*
100 Ω	1000 mS/cm	± 5 mS/cm	*1001* mS/cm	20.00	20.00	± 0.13	*20.00*	*20.00*

The tolerances specified relate to the performance of the IC402. Production testing is carried out in combination with a specially calibrated sensor. In the field, the accuracy and linearity of the sensor and test equipment affects the error in the reading. As much as an additional 0.1 mA may be seen in the mA output readings. After completing these tests Press ENTER. This automatically starts the next test.

5. Accuracy & Linearity Check mA output circuits

This test is automatically generated in service code 50. Step through this test by repeatedly pressing ENTER.

Simulated Output	Tolerance mA	Actual Output 1 mA *	Actual output 2 mA *
0.0	± 0.02	*0.00*	*0.00*
4.0	± 0.02	*4.01*	*4.00*
8.0	± 0.02	*8.01*	*8.01*
12.0	± 0.02	*11.99*	*12.01*
16.0	± 0.02	*16.01*	*15.99*
20.0	± 0.02	*20.00*	*20.01*
22.0	± 0.02	*22.01*	*21.99*

This test is completed when the Display reads (*S1).

6. Relay Operation Check

This test is also automatically generated in service code 50.
> Key is used to select the relay to be tested. S1, S2, S3 or S4.
^ Key is used to toggle between ON /OFF states of the relay chosen.
ENT Key is used to exit this test mode.

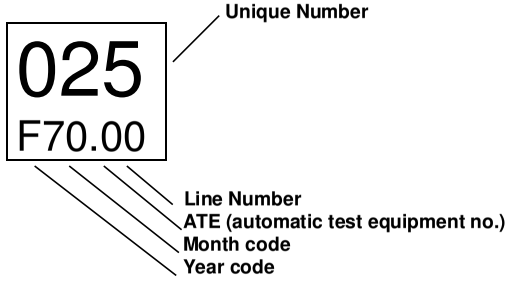
Relay Number	Actual *
S1	*OK*
S2	*OK*
S3	*OK*
S4	*OK*

Quality Inspection Standard

EXA Series
Model IC402
Converter for Inductive Conductivity

1. Introduction

This inspection procedure applies to the model IC402 microprocessor based converter. There is a serial number, unique to the instrument which is stored in non-volatile memory. Each time the converter is powered up, the serial number is shown in the display. An example is shown below:



2. General

Final testing begins with a visual inspection of the unit to ensure that all the relevant parts are present and correctly fitted.

3. Insulation Test

During the production testing procedures, the insulation is tested between terminal 3, the supply earth, and power terminals 1 and 2. The test used applies the following criteria:
AC instruments - 2.1 kV, <1 mA, for >1 min.
DC instruments - 0.7 kV, <1 mA, for >1 min.
The outputs are also tested for isolation from earth >10 MΩ.

4. Accuracy Testing

First check that output ranges are set to SC 0-1000 mS. Refer to page 15 Section 4.2 of the Instruction Manual. The automated checks in service code 50 are used in this procedure, and an IC40 sensor is connected and calibrated in conjunction with the converter. The test equipment needed is :

1. Resistance decade boxes with ranges of 10 Ω - 100 kΩ and 0.1 Ω - 10 kΩ with an accuracy of 0.1%.
2. Two 600 Ω resistors.
3. An inductive conductivity sensor (IC40) complete with 5 metres of cable.
4. An insulated wire with a length of approx 1 metre and a minimum cross-section of 0.75 mm^2
5. A power supply to suit the converter (115 /230 VAC or 24 VDC)
6. A mA meter with a range of 25 mA and an accuracy of 0.1% and a resolution of 1 µA.

Connect the IC402 as shown in Fig. 1. The lower range decade box (bank 1) to terminals 11 & 12 to simulate the temperature input. Set decade box 1 to simulate 25 °C (30 kΩ for NTC, 1097.3 Ω for Pt1000).

Quality Inspection Certificate

EXA Series
Model ISC402
Converter for Inductive Conductivity

1. Instrument Description

Model	:	Serial No.	:
Order	:	Release Version	:

2. General

OK

3. Insulation Test

OK

4.3 Accuracy Testing (Display)

Input	Display	Tolerance	Actual Display
100 Ω	10.00 mS/cm	± 0.05 mS/cm	mS/cm
1 k Ω	1.000 mS/cm	± 0.006 mS/cm	mS/cm
10 k Ω	100.0 µS/cm	± 1.0 µS/cm	µS/cm
100 k Ω	10.0 µS/cm	± 0.6 µS/cm	µS/cm
(Open) ∞ Ω	0.0 µS/cm	+ 0.5 µS/cm	**0.0** µS/cm

4.3.1 Temperature Display with integral NTC

Resistance	Temperature	Tolerance	Actual Display
158 kΩ	-10 °C	± 0.2 °C	°C
30 kΩ	25 °C	± 0.2 °C	°C
2069Ω	100 °C	± 0.2 °C	°C

4.3.2 Temperature Display with external Pt1000 RTD

Resistance	Temperature	Tolerance	Actual Display
960.7Ω	-10 °C	± 0.2 °C	°C
1097.3Ω	25 °C	± 0.2 °C	°C
1385Ω	100 °C	± 0.2 °C	°C

The tolerances specified relate to the performance of the IC402 with a calibrated sensor and purpose built test equipment. In the field, the accuracy and linearity of the sensor and test equipment affects the error in the reading. As much as an additional 1% of reading may be seen in the display.

4.3.3 Overall Accuracy Test

Input	Display	Tolerance	Actual Reading	Nominal mA 0-20 or 4-20		Tolerance mA	Actual mA1	Actual mA2
(Open) ∞ Ω	0.0 µS/cm	+ 0.5 µS/cm	**0.0** µS/cm	0.00	4.00	± 0.03		
500 Ω	200 mS/cm	± 1 mS/cm	mS/cm	4.00	7.20	± 0.05		
200 Ω	500 mS/cm	± 3 mS/cm	mS/cm	10.00	12.00	± 0.08		
125 Ω	800 mS/cm	± 4 mS/cm	mS/cm	16.00	16.80	± 0.11		
100 Ω	1000 mS/cm	± 5 mS/cm	mS/cm	20.00	20.00	± 0.13		

The tolerances specified relate to the performance of the IC402. Production testing is carried out in combination with a specially calibrated sensor. In the field, the accuracy and linearity of the sensor and test equipment affects the error in the reading. As much as an additional 0.1 mA may be seen in the mA output readings.
After completing these tests Press ENTER. This automatically starts the next test.

5. Accuracy & Linearity Check mA output circuits

Simulated Output	Tolerance mA	Actual Output 1 mA	Actual output 2 mA
0.0	± 0.02		
4.0	± 0.02		
8.0	± 0.02		
12.0	± 0.02		
16.0	± 0.02		
20.0	± 0.02		
22.0	± 0.02		

6. Relay Operation Check

Relay Number	Actual
S1	**OK**
S2	**OK**
S3	**OK**
S4	**OK**

Date:	Ambient Temperature °C Humidity %RH
Inspector: Signed:	Approved by: Signed:

YOKOGAWA HEADQUARTERS
9-32, Nakacho 2-chome,
Musashinoshi
Tokyo 180
Japan
Tel. (81)-422-52-5535
Fax (81)-422-55-1202
www.yokogawa.com

YOKOGAWA CORPORATION OF AMERICA
2 Dart Road
Newnan GA 30265
United States
Tel. (1)-770-253-7000
Fax (1)-770-251-2088
www.yokogawa.com/us

YOKOGAWA EUROPE B.V.
Databankweg 20
3821 AL AMERSFOORT
The Netherlands
Tel. +31-33-4641 611
Fax +31-33-4641 610
www.yokogawa.com/eu

YOKOGAWA ELECTRIC ASIA Pte. Ltd.
5 Bedok South Road
Singapore 469270
Singapore
Tel. (65)-241-9933
Fax (65)-241-2606
www.yokogawa.com.sg

Yokogawa has an extensive sales and distribution network.
Please refer to the European website (www.yokogawa.com/eu) to contact your nearest representative.

YOKOGAWA

IM 12D8C2-E-E
Subject to change without notice
Copyright ©

Printed in The Netherlands, 06-602 (A) Q